MARKET STRUCTURE AND GOVERNMENT POLICY PREFERENCES: THE UNITED STATES WINTER MARKET FOR FRESH TOMATOES

By

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In this study the structure of the US winter market for fresh tomatoes is determined and the influence of producers in Florida and consumers in policy formation is assessed over the period 1970-1992. Considerable conflict has been observed over time in the market between producers in Florida and Mexico, the only important import supplier, and between producers in Florida and consumers.

A strategic trade policy framework was adopted for the analysis and a duopoly model was developed to describe the market in which Florida and Mexico were the key players. A two-stage process was postulated in which the US government determined policy premised on optimal strategies by the respective industries. The industries took US government policy as given when determining their strategies.

Florida and Mexico were assumed to maximize profits and the US government maximized welfare mindful of the inıplications of policy for consumers and producers.

Welfare was defined as the weighted sum of producer's surplus, consumer's surplus and tariff revenue. Oligopoly power measures were developed for both industries. These measures facilitated an understanding of the extent to which market power emanated from demand and supply sides. The model also suggested what optimal policy might have been based on the disparity between what Florida anticipates Mexico's reactions would be and Mexico's actual reaction.

In the empirical application, a simultaneous equation model consisting of a linear demand function and linear supply relations was estimated used. Based on the parameter estimates, conjectural variations, conjectural elasticities, measures of market power, implicit marginal costs and the actual Mexican responses to a change in Florida's supply were computed.

The statistical evidence supported the presence of significant market power on the part of both industries. The market power was explained partly by an inelastic demand and partly by market share. Producers were generally more influential than consumers in policy formation although the weight of consumers was increasing over the period of the analysis.

CHAPTER 1

INTRODUCTION

Problem Statement

Competition between the state of Florida and Mexico in the US winter market for fresh vegetables has historically been significant (Bredahl et al., 1983, 1987). It has been most marked in the case of fresh tomatoes during the months January to April (VanSickle et al., 1994). Tomatoes are important in value terms to both these areas. Florida is the largest domestic supplier of fresh tomatoes, while Mexico supplies the bulk of the imports. Most of the imports take place within the first six months of the year with even greater concentration in the first three to four months. Florida and Mexico together supply over 90% of the market in the December to April period. Residual supplies come from other domestic sources and other countries.

The nature of this competition has undergone significant transformation over time. The share of the market attributable to Mexican exports increased significantly in the 1960s and 1970s (Zepp and Simmons, 1979; Bredahl et al., 1983). As a result of this, Florida attempted to erect protective barriers against Mexican supplies, first through the implementation of a marketing order regulation and, subsequently, through the filing of anti-dumping petitions. Mexican producers responded by adopting various strategies to control exports. Both sets of suppliers, with active government support, explored explicit market-sharing arrangements in the 1970s without success (Bredahl et al., 1983).

Several recent developments and trends have also affected the relationship of the supplying areas on the market. These include economic liberalization in Mexico since the mid-1980s, the growth of the Mexican domestic market, technological advances in the US relative to Mexico (Bredahl et al., 1983; Kalaitzandonakes and Taylor, 1990; Cook et al., 1991), and the relative stagnation of demand for fresh tomatoes in the US market. In addition, the implementation of the North American Free Trade Agreement (NAFTA) has changed the rules affecting the market and therefore can alter market behavior in the future. Among other things, tariff and non-tariff barriers will be eliminated over time, and land tenure reform and changes in the transportation sector can significantly affect efficiency in production and marketing.

US and Mexican governments have generally supported their industries and therefore have had the ability to influence market outcomes. However, the relationship between government and industry has not always been consistent. Support for producers has varied with wider domestic and international considerations. The US government had to balance the interests of producers and an alliance of consumers and distributors in the 1970s along with broader trade and economic policy objectives (Bredahl et al., 1987) while for Mexico, its trading and diplomatic relationship with the US has been a significant factor influencing its support for producers. Positions taken by governments have important distributional consequences.

Objectives

The objectives of this study are as follows:

(i) to determine the structure of the US winter market for fresh tomatoes; and

(ii) to assess the influence on US government policy of producers relative to consumers.

This study is important for the following reasons. First, the fresh tomato industry is significant in value terms to both Florida and Mexico. The value of Florida production in 1990/91 at the shipping-point was $576 million while that of the Mexican production was $103 million (VanSickle et al., 1994). Second, the fresh tomato market represents an interesting case in agricultural protectionism and competition. Producers in Florida and Mexico actively solicited the support of their governments to advance their interests in the market. US importers of Mexican fresh tomatoes along with consumers also lobbied the US government. Consumers are generally thought of as being less visible than producers in the trade policy process. In the case of the winter market for fresh tomatoes, however, consumers in association with importers of Mexican tomatoes were fairly visible in the 1970s and were largely responsible for the revocation in 1973 of a marketing order regulation intended to assist domestic producers at the expense of US consumers and Mexican producers (Bredahl et al., 1983). The strength of this coalition might also have been a factor in the US government's failure to find that Mexico had practiced dumping in the US fresh vegetable market. Third, the recent implementation of NAFTA raised anew the issue of competition between domestic and imported supplies and highlighted the adverse prospects for the US fresh fruit and vegetable sub-sector under this agreement. This sub-sector is one of the few US

agricultural sub-sectors expected to lose in welfare terms as a result of the implementation of NAFTA. If threatened by Mexican imports, producers in Florida can be expected to take action to protect their position in the market. Indeed, on March 29, 1995, Florida producers filed a petition for provisional relief from Mexican fresh tomato imports under Section 202 of the Trade Act of 1974. That petition was denied on April 14, 1995.

International markets are increasingly being recognized as imperfectly competitive and influenced by government policy. However, there have not been many empirical applications of imperfect competition models to international trade issues. Much of the available research relates to manufactures (e.g., automobiles, airlines) where concentration is obvious and the likelihood of market power is great. These industries lend themselves as ready subjects for strategic trade policy. The research in agriculture focussed on the international wheat and corn markets in which there are few firms and significant direct government intervention in the form of state trading. Overall, some studies suggest that rents are not available to any significant degree in international markets (Dixit, 1988; Krugman, 1992), negating any advantage that strategic policy may render. The implication of this is that the assumption of perfect competition is reasonable from the standpoint of policy. Other studies, however, indicate that empirical models which incorporate imperfect competition performed better than perfect competition models as representations of actual trade flows (Kolstad and Burris, 1986).

In addition, theoretical models which incorporate imperfect competition and address strategic interactions in international markets yield differing results depending

on the assumptions made, in particular, assumptions about the market behavior of firms, the nature of demand and costs, and whether markets are integrated or segmented (Eaton and Grossman, 1986; Cheng, 1988). Case studies are very important in the further development of international trade models with imperfect competition and strategic trade policy.

The present study examines the market for a highly perishable agricultural commodity, fresh tomatoes, using an empirical model of imperfect competition. Perishability, in itself, will tend to work against market power. However, government intervention in this market has been noteworthy and may have created circumstances favorable to the exercise of market power. A duopoly model which takes into account the ability of the supplying areas to exercise market power and which incorporates government policy is developed.

Methodology, Scope and Organization of the Study

This study utilizes a general conjectural variations model of duopoly in which the fresh tomato industries in Florida and Mexico are treated as firms and quantities are the strategic variables. This is a static, partial equilibrium approach which allows alternative hypotheses of market structure to be evaluated. Given optimal behavior by the industries, the US government maximizes a weighted welfare function of producer's surplus, consumer's surplus and tariff revenue. The assumption of a weighted welfare function allows the implicit values of the weights to be ascertained empirically.

Given the objectives of the study, the relevant literature includes theoretical and empirical studies on strategic trade policy, market power and market behavior, and

political preference functions. The market under consideration is the US winter market for fresh tomatoes. A homogeneous product is assumed on the presumption that there are no intrinsic differences between tomatoes supplied by Florida and those supplied by Mexico. For the purposes of this study, the winter market is circumscribed by the months January to April of each year. The study covers the period 1970 to 1992.

The rest of the study is organized as follows. In Chapter 2, some relevant background on the US winter market for fresh tomatoes is presented. Chapter 3 contains a review of the literature regarding strategic government intervention in non-competitive markets, the determination of the degree of market power and the type of market behavior, and political preference functions. In Chapter 4 the conceptual framework is developed. Chapter 5 covers the development and implementation of the empirical model and the presentation of the results. In Chapter 6, a summary of the entire study is presented along with the main conclusions and suggestions for further research.

CHAPTER 2

BACKGROUND

In this chapter, a brief account of the competition over time between Florida and Mexico in the US winter market for fresh tomatoes is given and, major recent developments capable of influencing this competition have been highlighted. A synopsis of the organization and structure of fresh tomato production and marketing is provided, marketing channels described and relative costs of production and marketing indicated. This provides useful background for the development of the analytical model and for the interpretation of the results.

The Main Suppliers of the Market

Florida and Mexico are the main areas supplying fresh tomatoes to the US winter market. Florida is the largest US domestic supplying state, producing from fall to spring. California is the second largest domestic supplier over the entire year. However, production in this state takes place from late spring to fall and therefore it does not participate in the winter market in any significant way. All other US domestic suppliers of fresh tomatoes are ruled out of the winter market by virtue of climatic considerations. High transportation costs restrict imports from sources other than Mexico, effectively rendering this country the lone supplier of imports to the US winter market. Average market shares for December to April for 1980/81-1990/91 were 56%

for Florida and 42% for Mexico, accounting for 98% of the market (VanSickle et al., 1994).

Market Relations Between Supplying Areas

Mexican production and exports of fresh vegetables, minor until the mid-1950s, increased significantly up through the 1970s. Factors responsible for this expansion included the cessation of trade with Cuba in 1962, the termination of the Bracero program in 1964 (Emerson, 1980, p. 4) and significant government investment in irrigation and transportation facilities in Mexico (How, 1991). The cessation of trade with Cuba presented an opportunity for Mexico to increase exports of fresh fruits and vegetables to the US. Cuba had previously been an important supplier of this market. The Bracero program allowed the large-scale use of cheap labor in the production of fresh produce in the US. Termination of the program reduced the availability of this low-cost labor, eroding the competitive position of many US states and enhancing that of Mexico. This led to a flow of US capital and expertise into production in Mexico. Although the high level of Mexican government expenditure in irrigation and transportation facilities was not specific to fresh vegetables, this sub-sector received considerable support. Market shares for Mexican fresh vegetables grew during this period at the expense of producers in Florida (Bredahl et al., 1983; Zepp and Simmons, 1979).

Fresh tomatoes headed Mexico's vegetable export expansion. Sustained increases in exports reduced Florida's market share and led producers in Florida to seek protection. An attempt was made by producers in Florida to use the Agricultural

Marketing Agreement Act (1937) to control supply and to implement regulations which discriminated against Mexican tomato imports (Bredahl et al., 1983). Specifically, a marketing order regulation stipulating dual sizing requirements for mature-green and vine-ripened tomatoes respectively, was implemented in 1969. At that time, most Mexican tomato exports were vine-ripes whereas most tomatoes produced and marketed by Florida were mature-greens. This requirement would have significantly reduced Mexican tomato exports (Bredahl et al., 1987). The specific provision was rescinded in 1973 as a result of pressure from an alliance of importers and consumer interest groups. This was particularly noteworthy since consumer groups had seldom actively protested attempts by US farmers to obtain import protection.

The efforts of Florida producers to obtain protection continued throughout the 1970s, culminating in anti-dumping petitions in 1978 and 1979. These petitions were filed after a resurgence of Mexican vegetable exports and increased Mexican market share, stimulated by the 1976 devaluation of the peso and adverse weather in Florida in 1976 and 1977. The first petition was filed in 1978 under the Anti-dumping Act of 1921 and its subsequent amendments. At the instigation of several US government agencies, Florida withdrew the petition in the hope that a settlement would have been reached whereby Mexican producers agreed to restrict shipments under certain special circumstances. The late 1970s was a time of great political and diplomatic sensitivity since the US government was negotiating several issues with Mexico, including energy, trade and immigration (Bredahl et al., 1987). When efforts at a settlement failed, the petition was re-filed in 1979. Ultimately, the US Department of Commerce ruled that

dumping by Mexico did not occur. Throughout the 1970s, there were numerous efforts by government and industry officials in both the US and Mexico to work out various mechanisms to coordinate supplies or otherwise share the market (Bredahl et al., 1983).

Although Florida failed to get protection, the sensitivity of its trade relations with the US led Mexico to adopt a system of export controls which ultimately reduced its market share (Bredahl et al., 1983). Programs which limited acreage and controlled export volumes were implemented and quality and maturity requirements were varied depending on market conditions. This export restraint policy was designed to forestall the imposition of more severe import restrictions by the US. However, it gave Florida sufficient room to develop and apply technologies which increased productivity. In the 1980s, Florida regained market leadership dominating the winter market with an average share of 53% in comparison with 28% for Mexico (VanSickle et al., 1994). Significant cost increases in Mexico relative to those in Florida (VanSickle et al., 1994; Bredahl et al., 1983) also contributed to Florida's increased market share.

Recent Developments Affecting the Market

In the post-war period up to the mid-1980s, the Mexican government pursued a highly interventionist policy in the wider economy and, specifically, in the agricultural sector. This policy had profound adverse effects on the structure and productivity of the agricultural sector (Congress of the United States, 1993). The system of land tenure limited the amount of land that individuals could hold for cultivation to 100 irrigated hectares. Although the larger farm groups in Mexico were able to circumvent this

restriction to some extent by registering land in the name of a number of individuals, this acted to discourage private investment and efficient land use.

In the mid-1980s, Mexico began a program of economic liberalization which continues under NAFTA. Since that time, the Mexican economy has experienced significant growth in absolute terms and relative to the US economy. The reduction in anti-export bias has served to stimulate exports and a marked inflow of foreign capital has occurred. Export expansion and foreign capital inflows are expected to continue for some time as NAFTA opens up markets, generates investment opportunities and stimulates productivity growth in Mexico (Congress of the United States, 1993). While economic and trade liberalization has adversely affected vegetable production in Mexico through the removal of producer subsidies and consequent increases in production costs, expected productivity increases will counteract these negative effects. Besides, there are prospects for a rapidly growing Mexican fresh tomato market given population and income growth trends. It is possible that continued growth of the domestic market will reduce Mexico's ability to expand exports to the US. However, the relative absence of resource constraints on production may allow Mexico to service both export and domestic markets. These developments have implications for the relationship between Florida and Mexico on the market and the resulting market structure.

Average US per capita consumption of fresh tomatoes over 1980-90 was 17.6 pounds (Organization for Economic Cooperation and Development, 1992). Per capita consumption increased at a slower rate than the availability of fresh tomatoes, generating a surplus and causing real prices to decline. This relative stagnation in demand holds the

potential for increased competition. This situation has probably been made worse by retailer behavior. Some growers and industry officials have contended that retailers, having recognized the inelasticity of demand for fresh tomatoes and having become accustomed to the higher profit margins which prevailed in the wake of the 1989 freeze, have been unwilling to carry the same volumes as in the past (Cook et al., 1991). Another noteworthy trend with implications for competition is the increase in the consumption of Roma tomatoes which are imported from Mexico. This trend suggests that Mexico may have the ability to enhance its market power somewhat through product diversification.

Organization and Structure of Production and Marketing

Relative concentration exists in fresh tomato production and distribution in Florida and Mexico (Bredahl et al., 1983; Emerson, 1980; VanSickle et al., 1994). Fresh tomatoes are currently produced by approximately 200 growers in Florida in the regulated area of the federal marketing order. Growers usually establish a relationship with one or more of some 80 registered tomato packers with whom they contract to handle, pack, ship and sell their produce. An estimated 30 packers handle 97% of the product sold in the national marketing system. Normally, packers assist growers in planning their production (VanSickle et al., 1994).

Production and marketing techniques in Mexico are similar to those in the US (Emerson, 1980). In general, production takes place on large private farms with modern equipment for grading, packing and shipping (How, 1991). At present, export production is controlled by some twelve large groups. Marketing is done by distributors

based in Nogales, Arizona, most of whom belong to the West Mexico Vegetable Distributors' Association (WMVDA). The larger groups of producers are often vertically integrated with their own distributorships in the US (VanSickle et al., 1994).

Production and marketing activities in Florida are supported by several organizations. These include the Florida Fruit and Vegetable Association (FFVA), the Florida Farm Bureau Federation (FFBF), the Florida Tomato Committee (FTC), the Florida Tomato Exchange (FTE), and the Florida Tomato Growers Exchange (FTGE). FFVA is a cooperative association of growers, shippers, packers and processors which sponsors programs in labor, marketing and production for all commodities in the fresh produce industry, including tomatoes. Marketing programs assist interested groups in developing cooperative strategies. Production programs help growers with periodic production problems. Among other activities, the FFVA supplies information used in making policy decisions concerning trade. The FFBF provides legislative support aimed at protecting the interests of the fresh vegetable industry. The FTC is a growers' committee which administers Federal Marketing Order No. 966 covering the majority of the tomatoes grown in Florida and imported during the regulated season from October to June. This committee recommends size, grade, container and inspection requirements for approval by the United States Department of Agriculture (USDA). Since 1986 it also has had responsibility for production research and education and promotion programs under the marketing order. The FTE, a state-wide cooperative of first handlers, undertakes lobbying efforts on behalf of the industry. It also provides collective action with respect to orderly marketing and distribution of fresh tomatoes and represents

virtually all first handlers and growers in the production area of the marketing order. The FTGE, whose membership comprised growers who produce more than 85% of the total volume in Florida (at the beginning of the 1990-91 season), is a growers' cooperative which provides collective action aimed at achieving orderly marketing and distribution.

Production and marketing of fresh vegetables in Mexico for export are coordinated through local, state and national cooperative federations. The two most important federations are the national vegetable growers' association, Confederación Nacional de Productores de Hortalizas (CNPH) and the Mexican state association, Confederación de Asociaciones Agricolas del Estado de Sinaloa (CAADES). CNPH comprises affiliated associations in each state and local associations within each state. CAADES is the most powerful state organization given the concentration of the fresh vegetable industry in the state of Sinaloa. It negotiates on behalf of growers with state and federal governments. These organizations implemented policies in the 1980s aimed at controlling the quantity and quality of vegetable exports.

The majority of the growers in Mexico are private land-holders who form groups to organize production and marketing. In large part, the formation of groups has been motivated by the need to circumvent constraints imposed by land reform laws whereby individuals could not cultivate more than 100 hectares of irrigated land. Larger groups of producers often have their own distributorships in Nogales, Arizona, where most of the fresh tomato imports from Mexico enter the US (VanSickle et al., 1994). Distributors handle the sales of Mexican tomatoes and are closely connected with

Mexican producers (Buckley et al., 1986; VanSickle et al., 1994). The most prevalent form of association between a distributor and a grower is partnership, primarily because of past Mexican restrictions on land ownership by foreign nationals (How, 1991). Some firms are owned by Mexicans and managed by US individuals while others are "independents" who contract with Mexican growers.

Most of the distributors who handle fresh produce imported from Mexico belong to the WMVDA. About 75 distributors have been registered members of this association since the mid-1980s (VanSickle et al., 1994). The WMVDA, along with consumer groups, was instrumental in the 1970s in preventing the escalation of protection against Mexican vegetable imports (Bredahl et al., 1987). Although this association maintains communications with CAADES and other associations in Mexico, there are no formal connections between the WMVDA and these organizations.

Marketing Channels

Tomatoes produced in Florida move from the field to the packing house for packing and distribution. After packing, the tomatoes are generally transported to wholesale and terminal markets by truck. These markets handle and deliver vegetables from warehouse storage facilities to retail and institutional outlets. Some of the tomatoes are repacked by wholesalers (re-packers) in order to meet the specific needs of retailers and the institutional trade (VanSickle et al., 1994).

Mexican tomatoes for export are shipped from the packinghouse mainly by truck to the US border at Nogales, Arizona, where they are subject to inspection by several Mexican and US agencies to ensure compliance with Mexican and US requirements.

Mexican and US custom brokers facilitate the movement of produce across the border. At present, Mexican truckers must off-load the produce at the distributors' storage sheds after which the distributors enter the produce into the marketing system. Once the produce reaches the US border at Nogales, Arizona, marketing channels are essentially the same as those for Florida.

Costs in Florida and Mexico

Several studies estimating costs of production and marketing have been undertaken over time (Buckley et al., 1986; Cook et al., 1991; VanSickle et al., 1994). The delivered cost of tomatoes produced in Florida has generally been lower than that of tomatoes produced in Mexico although the latter has had lower pre-harvest, harvesting and packing costs. Factors responsible for this situation are Mexico's higher marketing and transportation costs and lower yields. Production costs in Mexico, however, have been rising due to the removal of agricultural subsidies while those in Florida have been increasing because of relative resource scarcity (e.g., land) and increased regulation for health, environmental and immigration reasons.

Summary

Several events have occurred since 1970 which have affected the nature of competition between Florida and Mexico. These include the revocation of the controversial marketing order provision which stipulated different size requirements for Florida and Mexico; the filing of anti-dumping petitions; and the change in Mexican economic strategy. Commodity associations on both sides have been instrumental in influencing and implementing policy and Mexican and US governments have intervened

significantly in the market. Economic liberalization in Mexico and NAFTA may have further impacted market relations given the importance to Mexico of tomato exports. Other factors which have altered competition are the relative growth rates in productivity, demand stagnation in the US and capacity constraints. While Mexico has consistently had lower production, harvesting and packing costs, high transportation and marketing costs have meant higher delivered cost for Mexico than for Florida. The most significant competition between Florida and Mexico takes place at the shipping-point since marketing and distribution systems are the same for both sets of producers within the US.

CHAPTER 3

REVIEW OF THE LITERATURE

Theoretical arguments for incorporating imperfect competition in international trade models along with their shortcomings are presented in this chapter. In particular, the lack of generality of the results of conceptual models in this area and the need for case studies are highlighted. Some relevant empirical research is reviewed to elucidate the approaches followed, the main findings and related problems. A review of studies on market structure and market behavior indicating two major approaches to the determination of market power is also undertaken. Lastly, the relationship between interest group behavior and policy determination is discussed. Overall, the literature review is useful in informing the conceptual and empirical approaches adopted in this study.

Trade Models with Imperfect Competition

The need to model international markets as imperfectly competitive became increasingly recognized in the 1980s. Markets are imperfectly competitive for several reasons, including the paucity of firms, product differentiation and government cartelization indirectly through tax policy or directly through marketing arrangements (Eaton and Grossman, 1986). Governments intervene in imperfectly competitive markets because they present an opportunity to improve national welfare either by shifting or sharing available rents. Trade and industrial policies can provide a domestic firm with

an advantage in domestic and export markets. For instance, a tariff or production subsidy can assist domestic firms in the domestic market. An export subsidy can help domestic firms increase market share in export markets. Quantitative restrictions can facilitate collusion between foreign and domestic firms (Harris, 1989; Vousden, 1990; Helpman and Krugman, 1989).

However, optimal policies depend critically on the nature of oligopolistic competition. For instance, if firms engage in Bertrand rather than Cournot competition in an export market, and goods are imperfect substitutes, the optimal policy is an export tax rather than the Brander-Spencer recommendation of an export subsidy (Eaton and Grossman, 1986). Policy recommendations may not be definitive even under the assumption of consistent conjectures (Vousden, 1990). Besides, assumptions about demand, cost, market integration and policy interaction also affect optimal policies (Cheng, 1988).

Eaton and Grossman (1986) and Cheng (1988) attempted integrative treatments of trade and industrial policies within a general conjectural variations framework which allowed different forms of oligopolistic competition to be modeled. Eaton and Grossman, considering an export market, found that the sign of the optimal trade or industrial policy (i.e., whether tax or subsidy) depended on the relationship between the home firm's conjectural variations and the actual equilibrium reactions of the foreign firm. Cheng, examining competition between a domestic firm and a foreign firm in the domestic market, concluded that optimal policies were qualitatively sensitive to the nature of competition among firms.

The lack of robustness of the results emanating from theoretical trade models which incorporate imperfect competition and government policy highlights the need for determination of the behavior of firms on the market (Harris, 1989). Governments may misjudge actual firm conduct and firms may not take government policy as given. Indeed, governments may not know in advance their planned program of activities. In many ways, policies evolve out of ongoing interaction between governments and various interested groups. Case studies will aid the understanding of how markets function and how particular types of behavior are generated (Cheng, 1988). These studies are desirable notwithstanding claims that rents may be empirically insignificant because very few industries exist with large economies of scale and because entry is free in the long run (Dixit, 1988; Cowling and Mueller, 1978, Helpman and Krugman, 1989). Re-distributive effects may be large and rent-seeking policies can have substantial impacts on the welfare of specific groups (Harris, 1989).

International trade models which assume perfect competition are inappropriate when markets are imperfectly competitive. While a significant amount of theoretical work has been done incorporating imperfect competition and policy intervention, few empirical models have been implemented. Spatial equilibrium models have been widely applied in international agricultural trade, often on the assumption of perfect competition. However, the results of these models have generally been inconsistent with the actual functioning of agricultural markets (Kolstad and Burris, 1986; Paarlberg and Abbott, 1986).

In international agricultural markets, a few countries and often a few marketing agents account for most of the sales. Governments have intervened significantly in agricultural markets worldwide. The factors determining government policy, the extent of market power, and the behavior of firms on the markets have therefore become important. Empirical analyses of international agricultural markets examining these issues are warranted. Most of the empirical research to-date has examined international grain markets with very little on the implications for domestic markets. The following is a review of some of the empirical research on imperfectly competitive markets.

McCalla (1966) presented one of the early imperfect competition models in agricultural markets. He employed a cooperative duopoly approach in a study of price formation in the world wheat market. One seller was the leader and the other was the follower within a price-quantity band. Price was determined anywhere along the frontier of the area of cooperation which was set by the constraints and objectives of the duopolists. The framework allowed for the possibility of a duopoly breakdown and economic warfare if there were no coincidence between the set of possible price-quantity positions of the leader and the set of acceptable relationships for the follower. However, McCalla simply took the country as the appropriate market unit due to significant direct government intervention on both sides of the market but did not consider welfare and policy considerations.

Paarlberg and Abbott (1986) developed a conjectural variations model of the world wheat market. Domestic and trade policies were treated endogenously and they took into account market power as well as the influence of interest groups on policy.

Policy-makers formed conjectures of the excess demand or excess supply functions facing their respective countries. Equilibrium was determined by linking these conjectures with the domestic and trade policies of other countries.

Domestic and trade policies were determined so as to maximize welfare which was specified as a weighted sum of the welfare accruing to several political interest groups subject to a market-clearing constraint. Weights measure the policy-maker's attitude toward the welfare of the various groups. These were estimated along with the conjectures of the excess supply and demand functions by revealed preference. They were generally consistent with the actual policy positions of the respective countries. Lobbying by interest groups appeared critical to the policy-maker's position. On the basis of simulation, the model was found to perform better than a standard neoclassical model in which policy and market power considerations were not incorporated.

Kolstad and Burris (1986) assumed that governments coordinate producers and consumers and protect their respective interests so that imperfect competition can be modeled among countries. Using a nonlinear programming approach, they presented a conjectural variations model of spatial equilibria in oligopolistic and oligopsonistic markets. Equilibrium was given as the solution to a system of reaction functions. The model took on different forms depending on the type of conjectures held by market participants. On the assumption of Cournot-Nash behavior, the model was applied to the international wheat market and specific hypotheses of market conduct (duopoly, triopoly, duopsony and free trade) were tested. Theil and Spearman test statistics indicated that

imperfect competition assumptions performed better than free trade which was found to be generally inconsistent with actual trade flows.

Vanzetti and Kennedy (1989) presented a framework for analyzing strategic interaction in international trade, examining in particular how conjectural variations affect optimal policies. Welfare, defined as the unweighted sum of producer's and consumer's surplus and revenue from trade taxes, was maximized by setting trade taxes. They developed a linear trade model with import tariffs and export taxes/subsidies as the policy instruments. Aggregate conjectural variations were estimated from the observed tariff structure. These conjectures were used to conduct simulations, the results of which were compared with free trade and Cournot-Nash solutions in an empirical application to the world wheat market.

Sarris and Freebairn (1983) modeled the net impact of domestic pricing policies on international markets as the solution to a domestic welfare maximization problem. Welfare was specified as a weighted sum of producer's surplus, consumer's surplus, government treasury gains, and instability measures for producer and consumer prices. They assumed that the world price was given and that countries were concerned with domestic policies and not with other countries' reaction to their policies. This implied Cournot behavior. On the assumption that the difference between domestic and international prices can be maintained only by active government policy, welfare was maximized with respect to producer and consumer prices. Current levels and variability of domestic prices were used to estimate implicit welfare weights for producers, consumers and the government treasury in the major wheat trading countries.

Dixit (1988), analyzing the US automobile industry, employed a conjectural variations framework in an attempt to establish empirically whether import tariffs and domestic production subsidies could realize net welfare gains for the US. Only the domestic government was policy-active with a tariff and a production subsidy at its disposal. Optimal conditions incorporating conjectural variations were derived for foreign and domestic industries assuming linear demands and constant marginal costs. Conjectural variations were treated as parameters measuring the degree of competition in market conduct. Their values are determined from the data using "calibration."

The two aggregate first-order conditions together with the respective demand equations could be solved simultaneously for equilibrium prices and quantities, given the tariff and the subsidy. Prices and quantities could be used in a welfare function which is the sum of consumer surplus, industry profit, rent to labor and net tax revenue. Distributional considerations could be captured by attaching different weights to the respective components. While acknowledging several shortcomings of the analysis, Dixit found that economic gains to the US from trade and industrial policies were quite small.

Love and Murniningtyas (1992), in a study of Japan's participation in the international wheat trade, provided parametric test statistics for market power and for free trade. The model allowed alternative hypotheses of market power to be tested within a general framework. Specifically, tests were conducted for monopoly power, monopsony power, joint monopoly and monopsony power and free trade. Econometrically consistent supply and demand estimates along with market power parameters were derived. Substantial differences were found between elasticities derived

from the unrestricted model which imposed no assumption about market power and a free trade model.

Some of the empirical analyses of international trade with imperfect competition presupposed particular types of economic behavior (McCalla, 1966; Kolstad and Burris, 1986). Simulations would be conducted and conclusions drawn about the appropriateness of the assumed market structure by comparing the simulated outcomes with actual data (Kolstad and Burris, 1986). Rather than presume a particular market structure, it would be desirable to have alternative assumptions about market structure nested within a general model.

Many of the recent studies have adopted the conjectural variations framework or some other general framework which allows the underlying market structure to be established via tests of hypotheses (Appelbaum, 1982; Suzuki et al., 1993; Love and Murniningtyas, 1992). Some researchers have expressed reservations about the conjectural variations approach to the effect that is an intrinsically dynamic model "forced" into a static framework. However, this is not considered to be a problem if the conjectural variations are used to capture different forms of oligopolistic competition rather than as a model of expectations (Cheng, 1988; Dixit, 1988).

Some of the studies of imperfect competition in international trade which employ simulation arrive at conclusions about appropriate market structure for a few specific years (Vanzetti and Kennedy, 1989; Sarris and Freebairn, 1983; Dixit, 1988). These studies do not provide any insight into longer-term market behavior. In this regard, it would be more appropriate to ground conclusions on a statistical basis. In addition, some

of these studies employ demand and supply elasticities derived assuming perfect competition (Kolstad and Burris, 1986; Paarlberg and Abbott, 1986). If imperfect competition were present, elasticities should be derived taking this into account. Otherwise, a discrepancy would exist between the hypothesis underlying the simulations and the elasticities used to recover the market power parameters leading to possible error (Love and Murniningtyas, 1992). Proper simulation studies must use elasticities which are consistent with the presumed market structure. The above highlights the need for systematic econometric analysis to be applied in imperfect competition models.

Studies on Market Structure and Market Behavior

Conjectural Variations Models

Using a conjectural variations model, Appelbaum (1982) provided measures of the degree of oligopoly power for the firm and the industry. The measures were developed using the first-order condition for profit-maximization that firms equate perceived marginal revenue with marginal cost. With no restriction placed on the conjectural variations, this condition catered to a general behavioral mode which allowed alternative hypotheses about industry structure to be tested.

Appelbaum defined the degree of oligopoly power for the firm as

$$\left[\frac{P-MC}{P}\right] = \theta^j \varepsilon = \alpha_j \qquad (1)$$

where

$$\theta^j = \left(\frac{\partial y}{\partial y^j}\frac{y^j}{y}\right); \tag{2}$$

and

$$\epsilon = -\left(\frac{\partial p}{\partial y}\frac{y}{p}\right). \tag{3}$$

Market demand is given by y, price by p and j indexes the output of the j^{th} firm. This measure ranges in value from zero to one and is made up of the negative of the inverse demand elasticity, ϵ, and the conjectural elasticity, θ^j. Based on the measure for the firm, a measure of oligopoly power for the industry was defined as

$$L = \theta\epsilon = \sum \alpha_j S_j \tag{4}$$

where θ represents the equilibrium value of the conjectural elasticities for firms within the industry and S_j denotes the share of total output attributable to the arbitrary firm. In equilibrium, all firms are assumed to have identical conjectural elasticities. The industry measure is the weighted average of the firms' measures with the weights being the output shares of the respective firms. Like the measure for the firm, its value lies between zero and one.

The motivation for the industry measure was the impracticability of estimating oligopoly power using firm level data. Application at the industry level required that appropriate aggregation conditions be satisfied. The assumption that marginal costs are constant across firms was adopted. This implied that, in equilibrium, perceived marginal revenue was equal for all firms in the industry and equal to industry marginal cost.

Various types of market conduct are accommodated in this model. For instance, under Cournot behavior, the conjectural elasticities are output shares and equilibrium involves equal market shares for all firms in the industry, while $\theta=0$ for a competitive industry and $\theta=1$ for monopoly. Estimation of the model yields a value for θ which indicates the deviation of the underlying market structure from perfect competition and monopoly. In an application to the US rubber, textile, electrical machinery and tobacco industries, the first two industries were found to be characterized by competitive behavior and the last two by oligopolistic behavior.

Some researchers have employed the approach advanced by Appelbaum (1982) to estimate the degree of oligopoly power empirically (Appelbaum, 1982; Taylor and Kilmer, 1988; Schroeter, 1988; Azzam and Pagoulatos, 1990; Hazilla, 1991). This approach requires specification of market demand, an aggregate cost function and a parameterization of the conjectural elasticities. Demand is specified as a function of prices, income and other exogenous variables. Specification of the cost function must permit aggregation across firms in the industry. The generalized Leontief cost function (Appelbaum, Taylor and Kilmer; Schroeter) or some other semi-flexible form, (e.g., the symmetric generalized Barnett cost function (Hazilla, 1991)) was often applied to model costs which were considered a function of aggregate inputs, namely, labor, capital and intermediate materials. Conjectural elasticities were generally modeled as linear in input prices, the exogenous variables in the system, although other approximations might be viable.

Taylor and Kilmer (1988) studied market structure in the Florida celery industry under the federal marketing order. Point estimates of the index of oligopoly power suggested the presence of some degree of price enhancement over marginal cost pricing. However, the bulk of the statistical evidence indicated that departure from marginal cost pricing behavior was not statistically significant. It was concluded that pricing behavior in the Florida celery industry did not represent a statistically significant departure from a perfectly competitive market.

Azzam and Pagoulatos (1990) sought to establish the existence of oligopoly and oligopsony power in the U.S. meat packing industry. They hypothesized that the meat packing industry exerted some degree of market power; that the market power exercised in the industry was different in input and output markets; and that market power was likely to be higher in the input market. The authors applied Appelbaum's approach in both input and output markets. Empirically, they estimated a translog production function along with share equations for four inputs, namely, livestock, labor, capital, and non-livestock material. No demand equation was estimated and, therefore, the authors used exogenous (taken from other studies) market price elasticities. Their results supported the presence of market power in both input and output markets. The degree of market power in the factor market was found to be higher than that in the output market.

Schroeter (1988) modified the model proposed by Appelbaum to permit the measurement of monoposony power and monopoly power in an application to the beef-packing industry. He found evidence to support the existence of small

monopoly/monopsony price distortions in slaughter cattle and wholesale beef markets. On the assumption that the quantities of the material input and output could be represented by the same variable, and that the arbitrary firm could exercise power in both input and output markets, Schroeter was able to derive the following first-order condition for the firm:

$$P(1+\frac{\theta^j}{\eta})=w_m(1+\frac{\theta^j}{\epsilon})+\frac{\partial C^j}{\partial Q^j} \tag{5}$$

where P is the output price, w_m is the material input price, C^j is total cost, Q is output, η=elasticity of market demand; ϵ=the elasticity of material input supply; and θ^j=the conjectural elasticity of the firm. On the basis of this condition, the monopoly power of the firm could be given by

$$L^j=-\frac{\theta^j}{\eta} \tag{6}$$

and the monopsony power of the firm by

$$M^j=\frac{\theta^j}{\epsilon} \tag{7}$$

Due to limitations of data, Schroeter was unable to empirically implement the equation representing the demand for capital.

Hazilla (1991) estimated indexes of market power based on conjectural variations and market demand elasticities using various flexible functional forms. In particular, he

employed the symmetric generalized McFadden cost function, the symmetric Barnett cost function and the generalized Leontief cost function to model costs. Estimation was based on industry-level data that comprised twenty-one US manufacturing sectors. Hazilla's study, like most others, used a single supply relation to describe the supply of output. Evidence was found suggesting considerable market power in US manufacturing.

Suzuki et al. (1993) employed a conjectural variations approach to measure the degree of competition in Japanese milk marketing. They considered two supply relations which allowed them to examine the oligopolistic behavior of two marketing boards. Assuming a homogeneous product and using the standard purchase price as marginal cost, the conjectural variations for the marketing boards were estimated directly for each year. Estimated conjectural variations were used to identify the degree of market imperfection. The authors found evidence that the Japanese market for milk was imperfectly competitive.

Comparative Static Approaches

Bresnahan (1982) established that the parameter which indexes the degree of oligopoly power could be identified by standard econometric methods even when information on costs is lacking. The comparative statics of equilibrium, as price and quantity are shifted by exogenous variables, could reveal the degree of market power. Assuming linear demand and marginal costs, Bresnahan showed that the index of oligopoly power could not be identified without knowledge of marginal costs if movements in the exogenous variables in the demand function served only to shift its

intercept up and down. In this instance, the competitive solution was not "observationally distinct" from that of monopoly.

Identification requires generalizing the demand function to include variables which are capable not only of shifting the demand function up and down, but also of changing its slope. Only when the demand function rotates as well as shifts are the hypotheses of competition and monopoly observationally distinct. In general, rotations of the demand curve will have no effect if pricing is competitive but will have an effect if market power is present. The inclusion of interaction variables is sufficient to identify the oligopoly solution and to distinguish alternative hypotheses about competition. This result would hold even if the demand and marginal cost curves were not linear, if an inverse demand specification were utilized, and if product differentiation were incorporated.

Bresnahan's argument can be summarized graphically in figures 1 and 2. In figure 1, D_1 and MR_1 represent the initial linear demand curve and the corresponding marginal revenue curve; and MC^c and MC^m represent the marginal costs of a competitive industry and a monopolist respectively. It is readily seen that E_1 can be an equilibrium for either the monopolist with marginal cost MC^m or for a perfectly competitive industry with marginal cost MC^c. An exogenous shift in the demand curve to D_2, with cost curves MC^c and MC^m, causes the equilibrium point E_1 to shift outward to E_2. Like E_1, E_2 can be an equilibrium for either a competitive industry or for a monopolist. This means that unless marginal costs are known, there is no observable distinction between the hypotheses of competition and monopoly.

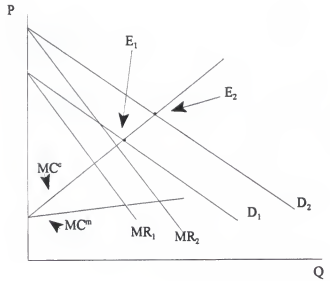

Figure 1. Oligopoly Power Not Identified
Source: Bresnahan

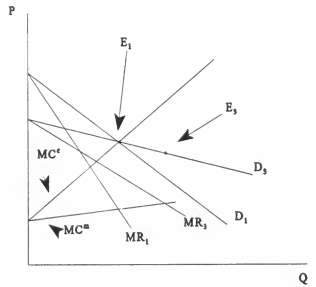

Figure 2. Oligopoly Power Identified
Source: Bresnahan, 1982

In order to be able to distinguish between competition and monopoly, the demand function must include exogenous variables which cause shifts in the intercept as well as changes in its slope. Consider figure 2 where MC^c and MC^m, D_1 and MR_1 are as in figure 1. Instead of shifting vertically as in figure 1, the demand curve is rotated around E_1 to give D_3 and MR_3. If marginal cost is that of a perfectly competitive industry, MC^m, E_1 will represent the equilibrium whether the pertinent demand curve is D_1 or D_3. However, if MC^m were the marginal cost curve and supply were monopoly, then the equilibrium shifts to E_3 where $MR_3=MC^m$. This establishes that if the demand curve shifts as well as rotates, the hypotheses of competition and monopoly are distinguishable.

Lau (1982) confirms Bresnahan's findings regarding the identifiability of the oligopoly solution and provides the exact conditions for parameter identification. These require that the inverse demand function not be separable in the set of exogenous variables, Z, and Z has dimensionality of at least two. If the inverse demand is separable in the set of exogenous variables, the index of competitiveness cannot generally be identified except for a special case.

The work by Aw (1993) represents a modified empirical version of the approach advanced by Bresnahan. A structural model of the demand and supply of a country's exports was developed to distinguish between competitive and non-competitive conditions in international markets. More specifically, a cross-section of four destination markets for Taiwan's footwear exports were examined for price-discriminating behavior on the part of Taiwanese exports. Separate export demand and supply equations were estimated for each of the four markets which allowed the degree of competition to vary according

to the market. Aw employed demand equations linear in the parameters which included variables which shifted as well as rotated the demand curve, namely, the price of a substitute product in export markets and the exchange rate. Generalized supply relations which accommodated competitive and non-competitive behavior were used. Support was found for the existence of market power in one of the four markets examined.

Liang (1989) developed a price reaction function model of oligopoly which was used to evaluate market behavior for the case of differentiated products in the U.S. breakfast cereal industry. Given demand, each firm maximized profit with respect to its own price and took account of its actions on the behavior of other firms in the industry. Equilibrium prices were determined by the intersection of the firms reaction functions. On the basis of the model, alternative hypotheses of competition could be tested.

In estimation, Liang employed linear demand and price reaction functions which were estimated simultaneously. The demand curve included demand shifters such as advertising expenditure and income along with the prices of competing products which served to rotate the curve. A variable measuring marginal costs was included in the price reaction functions. The empirical model allowed the estimation of direct and anticipated responses along with own- and cross-price elasticities.

The estimated conjectures were constant over the period of study. However, it was recognized that the behavior of firms can change over time. Indeed, Liang found support for a more generalized conjectural variation rather than constant conjectures. Non-competitive behavior was established as being present in the U.S. breakfast cereal industry.

Evaluation

Some limitations of Appelbaum's approach exist. The utility of this approach in practice rests on the success achieved in estimating marginal costs. Obtaining cost data reliable enough to permit factor demand estimation is difficult in practice. This is true with respect to capital, labor and material costs. However, the problem is perhaps greatest with regard to capital costs. A critical issue relates to the contribution of capital costs to marginal costs. Capital needs to be broken down into the price for capital services and the quantity (Bresnahan, 1989). Some researchers have neglected capital costs altogether because of difficulties of measurement (Dixit, 1988; Schroeter, 1986). Taylor and Kilmer acknowledged that the opportunity cost of capital was not considered. Failure to consider (certain aspects of) capital costs holds implications for the interpretation of the results. Consideration of these factors would increase marginal costs and lead to lower values of the market power measures.

There is also the issue of the appropriateness of the functional form used to model costs. This, however, can be addressed by exploring several alternatives or by using prior information on the industry to specify the technology. Besides, inappropriate specification of the conjectural elasticity can bias conclusions about market structure. The difficulties involved in obtaining reliable cost data and the sources of error which can be introduced as a result of inaccurate cost data and inappropriate specification of the conjectural elasticities make alternative approaches desirable.

Appelbaum's approach also restricts marginal costs to be constant and equal across firms, essentially for the purposes of satisfying the requirements for aggregation

from firm to industry level. This has meant that in equilibrium all firms in the industry display the same behavior, i.e., θ is the same for all firms. Some researchers (Holloway and Hertel, 1991; Bresnahan, 1989) contend that, in empirical research within the conjectural variations framework, there should be some allowance for heterogeneity among firms. Bresnahan suggests that the conjectural elasticity, θ, need not be restricted to be constant across firms but should be interpreted as the average of the conduct parameters of firms in the industry.

Bresnahan's approach facilitates the derivation of implicit marginal costs and circumvents the issue of the appropriateness of functional form for the conjectural elasticities. Under this approach the industry marginal cost is free to assume alternative arbitrary forms subject only to the condition that the reduced-forms for price and quantity remain invariant (Lau, 1982). Conjectural variations, conjectural elasticities and measures of oligopoly power (as advanced in Appelbaum) can readily be derived on the basis of this approach.

Interest Group Behavior and Policy Determination

Policies in general and agricultural policies in particular are determined by the set of interactions between interest groups and government agencies. Groups lobby for policies which support their economic and political positions. Governments must balance the conflicting interests of these groups in order to maximize an underlying policy preference function. Policies eventually implemented may provide positive net benefits to some groups and negative net benefits to others (Oehmke and Yao, 1990). Relative benefits depend on the influence of groups in the policy process as well as the costs of

undertaking political action and the costs of the redistribution of income. The less costly it is for government to redistribute income in favor of a particular group and the easier it is for that group to organize politically, the greater its influence in the policy process.

In general, producers have been better able to organize politically than consumers because smaller group size and more geographical concentration facilitate coordination and monitoring. However, consumers have increasingly been able to attain greater visibility in the policy process in the US since the early 1970s. Anderson (1982), for instance, states that the interests of consumers went largely unnoticed relative to producers in the agricultural/food sector until 1970s when inflation and greater consumer awareness changed the picture. Available empirical evidence also indicates that producers have been more heavily weighted than consumers in US wheat policy (Oehmke and Yao, 1990; Paarlberg and Abbott, 1986)

Oehmke and Yao (1990) estimated a policy preference function (PPF) comprised of consumer's surplus, producer's surplus and budget expenditures. According to this function, the government rationally chose policies, namely, target prices, stock changes and research expenditures with respect to the wheat industry, to maximize the preference function. The preference function was premised on the position that policies evolve from the interaction between interest groups and the government. Empirical models based on this premise postulate the policy instruments as the dependent variable. Broad criteria which correspond to the desires of the various interest groups represent arguments in the PPF.

The authors postulated a dynamic PPF. The effect of government policies on the value of the PPF was examined by evaluating the effects of the policies on the components of the PPF, namely, producer's surplus, consumer's surplus and government expenditures. Constant elasticity functional forms were specified for demand, supply, excess demand and the relationship between research and development and supply. These were used along with parameter estimates (elasticities) from other sources to compute demand and supply shifters in domestic and export markets. The estimated weights indicated that producers were weighted more highly than consumers but consumers became more important over the period 1977 to 1985. This was consistent with claims that agricultural producers lost some political power to consumers in the late 1970s and early 1980s. Traditionally, the U.S. government had been prone to redistribute income in favor of farm producers.

Paarlberg and Abbott (1986) estimated welfare weights attached by policy makers to various interest groups using a revealed preference methodology. The estimated weights were different from one and were different for different groups. This provides some evidence that not all groups are equally influential from the standpoint of policy. They also provided evidence that, over the period 1960-77, consumers were weighted less than wheat producers in the US.

CHAPTER 4

ANALYTICAL METHODS

The conceptual framework and analytical model are set out in this chapter. Under conceptual framework, the assumptions are stated and discussed. The analytical model comprises two parts, namely, the solution of the industries' profit-maximization problems and the solution of the US government's welfare maximization problem. Measures of oligopoly power are developed using the first-order conditions of the respective industries. This allows an assessment of the relative market power held by Florida and Mexico. Premised on optimal behavior by the industries, an optimal condition for welfare maximization is also derived.

The Conceptual Framework

Florida and Mexico compete in the US winter market for fresh tomatoes. In this period, these two supplying areas consistently satisfy over 90 percent of the market. Both industries, therefore, are in a position to exercise market power and influence prices. Entry is restricted since climate (seasonality) and transportation costs prevent other US states and other countries from supplying significant amounts to the market in the winter period. It is assumed that Florida's sales go only to the domestic market while the entire Mexican output is exported to the US. Some Florida fresh tomatoes are in fact exported to Canada. This is also true of Mexican fresh tomatoes. However, the US and Canadian markets for fresh tomatoes are essentially not separate (Bredahl et al.,

1983). For the purpose of this analysis, the market is delineated by total shipments by Florida and Mexico. The terms and conditions of sale are the same whether purchases at the shipping-point are for delivery in the US or Canada. The assumption that the entire Mexican output is exported allows the effects of the domestic market in Mexico to be ignored. The industry in Sinaloa, Mexico, was developed specifically to cater to the export market in the US. Until recently, most of the production was exported to the US with the Mexican domestic market treated as a residual market.

Both industries are treated as firms. This assumption can be justified on several grounds. First, the bulk of the supply is accounted for by a relatively small number of large commercial farms which utilize similar production techniques (Bredahl et al., 1983; Emerson, 1980). This is true of both Florida and Mexico. Both industries are located in small geographical areas implying that producers face similar economic and climatic environments (Shonkwiler and Emerson, 1982). Besides, in the case of Mexico, the Mexican government, with the assistance of producer associations at national, state and local levels, actively coordinated production and exports for most of the period under review. Coordination involved the allocation of acreage for export production along with the allocation of export volumes at national, state and local levels (Bredahl et al., 1983; Myers, 1978).

The US Federal Marketing Order No. 966, administered by the FTC, authorizes minimum grade, size and maturity requirements. These quality restrictions reduce the quantities available in the short run and therefore are an indirect means of quantity control (USDA, 1981). Although no direct quantity controls are permitted under the

marketing order, commodity associations, in particular the FTE and FTGE have played a role in coordinating supplies from Florida through the implementation of orderly marketing programs (VanSickle et al., 1994). Given the similarities in production techniques and significant coordination of production and marketing, the treatment of the respective industries as firms is considered appropriate. Production and export controls in Mexico, and volume control and market flow schemes operated by Florida, together with their significant market shares put the respective industries in a position to exercise market power.

The Mexican and US governments have generally supported their respective industries presumably in an effort to secure strategic advantage for them and to increase domestic welfare. The present analysis focuses on the extent to which rents are available in the winter market for fresh tomatoes and on the relative welfare weights attached to producer's and consumer's surplus in the US which are implied by the policies pursued by the US government, namely, the import tariff and the marketing order. The US government is assumed to maximize welfare which is defined as the weighted sum of producer's surplus, consumer's surplus and government revenue.

In the development of the conceptual model, the import tariff is used as the sole policy instrument. The tariff can easily be represented by time series data in the empirical application. However, it is recognized that the provisions of the marketing order also affect variables closely associated with the economic well-being of specific groups, namely, prices and quantities. No explicit attempt is made to model the marketing order since grade, size and maturity requirements have changed over the

period which would make incorporation of the marketing order into the model difficult and also because the objectives of this study do not require it. The results of the analysis, however, are interpreted bearing the existence of the marketing order in mind. The weights attached to the welfare components measure the policy-makers' response to the interests of the different groups. There is no clear theoretical guide as to what the empirical values of the weights should be. However, expectations are that the weight attached to consumer's surplus would be less than that for producers.

Markets are assumed to be segmented, i.e., there is no effective arbitrage between the Mexican and US domestic markets. Segmentation is a reasonable assumption for much of the period under review, given the export orientation of the Mexican industry (Bredahl et al., 1983) and the fact that there are virtually no shipments from Florida to Mexico. Until recently, only small quantities produced by Mexican growers were sold on their domestic market which was treated as a residual market. Lately, the Mexican market has been growing (Cook et al., 1991) and, if this trend continues, it may be necessary to take it into account in subsequent analyses. Within the US, the market is assumed to be perfectly integrated. Jordan and VanSickle (1995), analyzing prices at shipping point, found support for market integration in the winter market.

The product is assumed to be homogeneous and therefore the industries supply perfect substitutes. The assumption of perfect substitutes implies that both sets of suppliers face the same elasticity of demand and that it is possible to sum the supplies from both areas to obtain total quantity. Although it is recognized that some quality differences may exist, these are not considered significant enough to render this

assumption inappropriate. The US International Trade Commission recently concluded that there was no significant differences between fresh tomato imports and corresponding US domestic products (USITC, 1995). It must be noted that Roma tomatoes, as distinct from "round" tomatoes, have become more important in total Mexican fresh tomato exports since the mid-1980s. Romas accounted for only 3% of total Mexican export production in 1980-81 compared with 23% in 1990-91 (Cook et al., 1991). This is a significant development that can later on differentiate the Mexican product from Florida's. However, this trend is recent in terms of the period of analysis.

The industries are assumed to maximize profits taking the tariff as given, with quantities as strategic variables. The assumptions of product homogeneity and market integration imply that a single price prevails in the market at the shipping point. The industry is considered small compared with the rest of the economy and, therefore, partial equilibrium analysis is used (Dixit, 1988; Brander and Spencer, 1984). The analysis focuses at the shipping-point (import) level where the most significant competition between Florida and Mexico takes place.

The Analytical Model

Domestic demand comes from a utility function which can be specified as

$$U=Q_0+U_R(Q) \tag{8}$$

where Q_0 is aggregate consumption of a numeraire good, U_R is the subutility function for fresh tomatoes, and Q represents the consumption of fresh tomatoes. Two industries supply quantities q_i; i= u,m representing the US (Florida) and Mexico respectively. The products are assumed to be perfect substitutes so that

$$Q=q_u+q_m. \tag{9}$$

Given this assumption, the inverse demand function of shippers and distributors is

$$P_i=P(Q)=P(q_u+q_m); \quad \frac{\partial P}{\partial Q}<0. \tag{10}$$

The present research is conducted at the import level and, therefore, does not address the profitability of marketing and distribution within the US beyond the shipping-point. Policies relating to points further along the marketing chain and the market parameters (e.g., supply and demand elasticities) which obtain at these points can modify conclusions made with respect to the shipping-point level.

The cost functions of the respective industries are given by

$$C_i = C_i(q_i,Z_i) \tag{11}$$

where Z_i represents a set of other relevant variables including input prices. Input prices are considered exogenous and are assumed to be different across industries. The industries are not considered large enough to affect input prices. However, the market conditions for inputs in Mexico will differ from those in Florida. The cost function for Mexico is assumed to incorporate transportation and other transfer costs to the US border.

Both industries are assumed to maximize profits. Mexico faces a specific import tariff (T) in the US market. The problems for the domestic and foreign industries are to choose q_u and q_m respectively so as to maximize profits, π_u and π_m:

$$\pi_u = P(Q)q_u - C_u(q_u, Z_u) \tag{12}$$

and

$$\pi_m = P(Q)q_m - C_m(q_m, Z_m) - Tq_m. \tag{13}$$

It is assumed that the US government maximizes welfare by choosing the import tariff optimally. The recent implementation of NAFTA would mean the eventual elimination of the tariff. However, the tariff was in place for the entire period of the analysis. Welfare is given by the weighted sum of the welfare accruing to the various interests groups (Paarlberg and Abbott, 1986). A review of the historical development of the winter market for fresh tomatoes would reveal that producer and consumer interests actively tried to influence policy with respect to the importation of tomatoes from Mexico. The weighted welfare function allows for the possibility that producers and consumers may have unequal influence on policy formation. In the present study, it is given by the weighted sum of producer's surplus, consumer's surplus and government revenue from the tariff as

$$W_u = \alpha[U(Q) - PQ] + \beta\pi_u(.) + \delta Tq_m \tag{14}$$

where $Q = q_u + q_m$ is determined by the equilibrium of the two industries and α, β and δ represent weights attached to consumer's surplus, producer's surplus and government revenue from the import tariff respectively. The weights capture the propensity of interest groups to influence government policy or indicate the attitude of the government towards the groups. The ascertainment of these weights empirically therefore facilitates

a ranking of the influence of these groups in the policy process. Welfare is maximized conditional on optimal industry behavior.

A general conjectural variations model of duopoly is developed to cater to the possibility that the industries may exercise market power. This is an appropriate approach when the assumption of price-taking behavior can be questioned. A conjectural variation is a firm's hypothesis about the reaction of rival firms to changes in its own strategic variable, in this instance, quantity. Different market structures result depending on the nature of the conjectures held by firms. For instance, if the subject firm assumes that other firms will not respond, then it acts in a Cournot fashion; if it assumes that other firms will adjust quantity so as to keep the market price constant, then it is acting in a competitive manner (Varian, 1984). The conjectural variations assumption allows for different forms of oligopolistic competition resulting from market strategies to be incorporated in one model.

In a general conjectural variations framework, the first-order conditions corresponding to the profit-maximization problems for Florida and Mexico respectively are found by differentiating (12) and (13) with respect to q_u and q_m respectively. These are

$$P(Q)+q_u P'(Q)\frac{dQ}{dq_u}-C_u'=0 \tag{15}$$

and

$$P(Q)+q_m P'(Q)\frac{dQ}{dq_m}-C_m'-T=0. \tag{16}$$

Since

$$dQ = dq_u + dq_m, \tag{17}$$

(15) and (16) can be re-written as

$$P(Q) + q_u P'(Q)[1 + r_{umu}] - C_u' = 0 \tag{18}$$

and

$$P(Q) + q_m P'(Q)[1 + r_{mum}] - C_m' - T = 0 \tag{19}$$

where $r_{umu} = dq_{um}/dq_u$ and $r_{mum} = dq_u/dq_m$ are the conjectural variations of Florida and Mexico respectively.

These optimal conditions can be expressed in terms of conjectural elasticities and the inverse demand elasticity (Appelbaum, 1982)

$$P[1 - \theta_u \varepsilon] = C_u' \tag{20}$$

and

$$P[1 - \theta_m \varepsilon] = C_m' + T \tag{21}$$

where

$$\theta_u = \frac{\partial Q}{\partial q_u}\frac{q_u}{Q}; \qquad \theta_m = \frac{\partial Q}{\partial q_m}\frac{q_m}{Q} \tag{22}$$

are the conjectural elasticities of total quantity with respect to the quantities of industries u and m respectively, C_u' and C_m' are marginal costs for Florida and Mexico respectively, and ϵ is the negative of the inverse demand elasticity. The condition for Florida states that perceived marginal revenue must be equal to marginal cost while in

the case of Mexico, it states that perceived marginal revenue must equal marginal cost plus the import tariff. Perceived marginal revenue is the increase in revenue that one industry expects to receive by producing one more unit of output which is always less than the price but may exceed the true marginal revenue that would prevail if the industry acted in concert (Helpman and Krugman, 1989).

The conjectural elasticities involve the industries' market shares and their conjectural variations. If no restrictions are placed on the conjectural variations (i.e., if no specific assumptions about behavior are imposed), they can cater to alternative hypotheses regarding market behavior. A competitive firm sets output at the point where price equals marginal cost. This implies a conjectural variation of -1 (Varian, 1984; Rogers, 1989). This can readily be seen by noting that $\theta_u=(1+r_{um})(q_u/Q)$ and $\theta_m=(1+r_{mu})(q_m/Q)$ and substituting in (20) and (21). If the two industries act in a perfectly competitive manner, then $r_{um}=r_{mu}=-1$ and $\theta_u+\theta_m=0$. Under the assumption of Cournot behavior, the conjectural variation is zero since the firm sets its output on the assumption that its rival does not change its output in response. This implies that the conjectural elasticities are simply the respective market shares. If average market behavior follows Cournot, then $r_{um}=r_{mu}=0$ and $\theta_u+\theta_m=1$. Collusive behavior requires that the conjectural variations equal the inverse of the market share minus 1. This means that $r_{um}=Q/q_u-1$ and $r_{mu}=Q/q_m-1$. Substitution in (20) and (21) reveals that the respective industries equate marginal revenue with marginal cost in the case of Florida and with marginal cost plus the import tariff in the case of Mexico. Collusive behavior implies that $\theta_u+\theta_m=2$. Therefore, as the sum of the conjectural elasticities tend to zero, market

behavior is more competitive. If their sum tends to one, behavior moves towards Cournot. As their sum moves toward a value of 2, firms behave in a collusive manner.

On the basis of (20) and (21), measures of market power for Florida and Mexico respectively can be derived as follows:

$$\frac{[P-C_u']}{P}=\theta_u \varepsilon \tag{23}$$

and

$$\frac{[P-C_m'-T]}{P}=\theta_m \varepsilon. \tag{24}$$

These measures, the respective ratios of profit margin to price, are Lerner indices of monopoly power. They indicate the extent to which the industries are able to obtain rents in the market. Note that the measures of market power are a product of the conjectural elasticity and the inverse demand elasticity. Market power cannot be inferred solely from the demand elasticity (Bulow and Pfleiderer, 1983) or from market shares. These are only elements in a broader measure. Ceteris paribus, the greater the conjectural elasticity or the more inelastic the demand, the greater is the market power. Increases in marginal costs would reduce the degree of market power and a decrease in the tariff would increase the market power held by the Mexican industry.

In comparison with previous work (Appelbaum, Hazilla, Taylor and Kilmer, Schroeter), the conceptual framework splits the market on the supply side between two suppliers and allows an evaluation of the relative power of the industries in an international trade setting. A conclusion can be drawn as to whether Florida or Mexico is dominant in the market. This represents a modification with respect to earlier work

which considered a single supply relation and the extent of market power in the industry as a whole. The framework also allows the examination of alternative hypotheses of market conduct and the derivation of implicit marginal costs. The estimated conjectural elasticities, measures of oligopoly power, and the implicit marginal costs are allowed to vary by year. This facilitates an interpretation of the results in terms of the development of the market over time.

In the present analysis, a homogeneous product was assumed. As indicated before, any intrinsic product differences are not considered sufficiently important to warrant the assumption of differentiated products. The assumption of a homogeneous product does, however, put the emphasis on relative costs as the critical factor determining the market behavior of the two industries.

Even in a market for a homogenous product, different types of oligopolistic behavior are possible depending on the firms' marginal costs (Ono, 1978). Firms would tend to compare the profit they would make as price-taker and as price-maker to determine their behavior. A stable asymmetric duopoly is possible. In this case, it is more profitable for the more efficient firm to be price-maker and for the less efficient firm to be price-taker. A price-taker/price-taker scenario which might result in Bertrand-type competition is also possible. This occurs when one firm's efficiency is not so different from the other's and therefore it is more profitable for both firms to be price-takers. A Stackelberg disequilibrium in which both firms attempt to be price-maker at the same time cannot exist. Therefore, if marginal costs for Florida and Mexico are similar, market behavior would likely be more competitive; if there is a substantial

disparity in the marginal costs of the two industries, then a stable leader-follower arrangement is possible.

The US government maximizes welfare conditional on the two industries behaving optimally. The Mexican government is assumed to be inactive from the standpoint of policy. This assumption does not compromise the objectives of the study which concern the ascertainment of market power and policy preference weights in the US although, in practice, some retaliation from Mexico may be expected in response to policy positions adopted by the US government. The change in US welfare resulting from a small change in the import tariff is

$$\frac{dW_u}{dT} = -\alpha Q\frac{dP}{dT} + \beta[P - C_u' + q_u P']\frac{dq_u}{dT} + [\beta q_u P' + \delta T]\frac{dq_m}{dT} + \delta q_m \tag{25}$$

Substituting the first-order condition for the Florida industry into (25) yields

$$\frac{dW_u}{dT} = -\alpha Q\frac{dP}{dT} + \beta\left[\frac{r_{um}(P - C_u')}{1 + r_{um}}\right]\frac{dq_u}{dT} - \left[\frac{\beta(P - C_u')}{1 + r_{um}}\right]\frac{dq_m}{dT} + \delta T\frac{dq_m}{dT} + \delta q_m \tag{26}$$

Equation (26) can be expressed as

$$\frac{dW_u}{dT} = \frac{[\delta q_m - \alpha Q\frac{dP}{dT}]}{\frac{dq_u}{dT}} + [\beta\frac{P - C_u'}{1 + r_{um}}][r_{um} - g] + \delta T g = 0 \tag{27}$$

This condition can be used to evaluate the optimality of the tariff and to assess the relative weights placed by policy-makers on the interests of consumers and producers.

It states that the optimal tariff depends, among other things, on the disparity between Florida's conjecture (r_{um}) and the realized slope ($g=(dq_m/dT)/(dq_u/dT)$) of the Mexican reaction function. If $g > r_{um}$, then equilibrium output in the absence of the tariff entails a greater Mexican quantity than anticipated because Florida does not take full account of Mexico's reaction to an increase in its own quantity. If $g < r_{um}$, Florida's output more than fully reflects Mexico's actual reaction. In the former case, the optimal import tariff is positive while in the latter it is negative. A consistent conjectures equilibrium obtains when $r_{um}=g$, i.e., when the conjectured and realized responses are equal. A comparison of empirical values for r_{um} and g provides information on what the optimal policy might be.

In this study, welfare was assumed to be maximized by the US government which chose the import tariff optimally. However, it is readily conceded that the tariff was unlikely to be optimal if only because basic tariff rates have not changed over the period of analysis. The US government also intervenes by way of the federal marketing order. The marketing order affects international trade in that the provisions apply to imports as well as domestic production. This instrument has been more actively manipulated over the period. Several modifications have been made to the marketing order by the Secretary of Agriculture (USDA) on the recommendation of the producers. The quantities supplied by Florida and Mexico would have reflected the effects of the import tariff and of the marketing order.

The optimal level of the tariff is no longer an issue of consequence from the standpoint of policy. This is because basic tariff rates have remained unchanged for a

considerable time. Besides, NAFTA provides for its elimination after ten years. Hence, this study will not be concerned with whether the tariff was optimal. A more pertinent issue relates to implicit weights put on producer's surplus and consumer's surplus. Groups lobby for policies in line with their own interests and the actual quantities traded along with prices and marginal costs have implications for the relative benefits received by the respective interest groups.

In the 1970s, there was a clear conflict of interest between producers in Florida and distributors of Mexican imports and consumers in the US which resulted in the revocation of a marketing order restriction which adversely affected fresh tomato imports from Mexico. Consumers perceived a reduction in their welfare due to restrictions on alternative supplies and the poor quality of fresh tomatoes from Florida (Bredahl et al., 1983). More recently, however, fresh vegetable producers in Florida were able to obtain some guarantees in the form of a side-agreement under NAFTA. Specifically, section 316 of the NAFTA Implementation Act requires that the US International Trade Commission monitor the imports of fresh (and chilled) tomatoes until January 1, 2009, for the purposes of providing relief to US growers in the instance of import surges. Producers in Florida can be expected to step up their lobbying efforts if they were to face increased competition from Mexican growers in the wake of NAFTA. In fact in March, 1995, they filed petitions for provisional relief against Mexico for this very reason.

The US government may be reluctant or unable to implement border measures which appear to run counter to the spirit of NAFTA. It may be under pressure from producers to implement other policies and may likely grant more obscure forms of

protection. For instance, increased technology-enhancing agricultural research or the implementation of discriminatory practices under the federal marketing order are possibilities. The impact of these policies will ultimately be borne out in the prices and quantities prevailing on the market and these will mean differential benefits to consumers and producers. The relative importance of producers and consumers will therefore continue to be an issue of relevance.

The estimation of the weights attached to the welfare of these groups is proposed to provide information on the influence of producer and consumer interests on policy formulation. Such information can be helpful in guiding future policy. From previous conceptual and empirical work, consumers are expected to have less weight than producers in the policy process. Conceptual analyses suggest that producers are generally better able to organize politically than consumers because of smaller group size and geographic concentration. Consumers, on the other hand, are a more diverse group which makes political organization more difficult and more costly.

CHAPTER 5

EMPIRICAL ESTIMATION, RESULTS AND DISCUSSION

This chapter contains the specification and description of an empirical model of the US winter market for fresh tomatoes and shows, in particular, how conjectural variations, conjectural elasticities and indices of market power can be derived. It also shows how the empirical weights on consumer and producer surplus can be established. Finally, the results are presented and implications drawn.

Specification and Description of the Empirical Model

The approach adopted in this study combines the conceptual framework of Appelbaum with the empirical methodology proposed by Bresnañan (1982). As previously indicated, conjectural variations, conjectural elasticities, and the measures of oligopoly power can be recovered on the basis of the latter. Hence, the estimation procedure in this analysis follows Bresnahan.

Empirical estimation of oligopoly power indexes for Florida and Mexico requires the specification of a market demand function and two general supply relations. Demand is expressed in inverse form as a function of the total quantity of fresh tomatoes at the shipping-point, income per capita and a variable affecting demand, Y, which enters on its own as well as in interaction with total quantity. Y must be capable of changing the slope of the demand curve which is a requirement for the econometric identification of

the index of oligopoly power (Bresnahan, 1982). The general form of the demand function is

$$P = P(Q,INC,Y). \tag{28}$$

The first-order conditions for profit-maximization given by (18) and (19) represent the implicit generalized supply relations of the industries in Florida and Mexico respectively. These can be expressed in terms of price as

$$P = C_u' - P'[1+r_{um}]q_u \tag{29}$$

and

$$P = C_m' - P'[1+r_{mm}]q_m + T \tag{30}$$

where C'_u and C'_m are marginal costs. The supply relations depend on the quantities and marginal costs which in turn are functions of quantities and input prices. Equations (29) and (30) demonstrate that the price suppliers receive is equal to marginal cost (interpreted broadly in the case of Mexico to include the import tariff) plus a mark-up which is determined by the demand elasticity and the conjectural elasticities.

The structural model can be specified empirically by the following system of equations

$$P = a_0 + a_1 Q + a_2 INC + a_3 Y + a_4 QY + v_1 \tag{31}$$

$$P = b_0+b_1q_u+b_2w_u+b_3F+v_2 \tag{32}$$

$$P = c_0+c_1q_m+c_2w_m+c_3T+c_4F+c_5EXC+v_3 \tag{33}$$

$$Q=q_u+q_m \tag{34}$$

where (31) is the demand equation; (32) and (33) are the supply relations for Florida and Mexico respectively and (34) is an identity indicating the breakdown of total quantity. Y enters the demand equation linearly as well as in interaction with Q. The interaction term, as indicated earlier, serves the comparative static requirement for identification of the index of oligopoly power. The variables, w_u and w_m, are vectors of input prices, F represents the occurrence of a freeze in Florida, T represents the import tariff, EXC is the US-Mexico exchange rate and v_1, v_2 and v_3 are appropriate error terms. This system of equations can be estimated simultaneously. The parameters b_1 and c_1, measure the slopes of the supply relations. Referring to (29) and (30), it can be seen that these parameters are functions of the slope of the demand curve and the conjectural variations and are equal to $-P'[1+r_{um}]$ and $-P'[1+r_{mu}]$ respectively.

From the demand equation, the negative of the inverse demand elasticity can be derived as follows

$$-\frac{\partial P}{\partial Q}\frac{Q}{P}=-[a_1+a_4Y]\frac{Q}{P}=\epsilon \tag{35}$$

Note that the slope of the demand curve (a_1+a_4Y) changes with Y. Given the estimate of P', namely, a_1+a_4Y, from the demand equation, the conjectural variations r_{um} and r_{mu}, can be determined from estimates of the parameters b_1 and c_1 respectively as

$$r_{um} = \frac{b_1 + (a_1 + a_4 Y)}{-(a_1 + a_4 Y)} \tag{36}$$

and

$$r_{mu} = \frac{c_1 + (a_1 + a_4 Y)}{-(a_1 + a_4 Y)} \tag{37}$$

Having obtained estimates of the conjectural variations, the empirical values of the conjectural elasticities can be found according to the following:

$$\theta_u = \frac{b_1}{-(a_1 + a_4 Y)} \cdot \frac{q_u}{Q} \tag{38}$$

$$\theta_m = \frac{c_1}{-(a_1 + a_4 Y)} \cdot \frac{q_m}{Q} \tag{39}$$

These values for the conjectural elasticities can then be used in conjunction with the estimate of ϵ to establish the extent of oligopoly power. The measures of oligopoly power for Florida and Mexico respectively are given by the following expressions:

$$\theta_u \epsilon = b_1 \frac{q_u}{P} \tag{40}$$

and

$$\theta_m \epsilon = c_1 \frac{q_m}{P}. \tag{41}$$

This approach facilitates the estimation of the measures of oligopoly power without explicit specification of marginal costs. Indeed, the empirical values of marginal

costs can be inferred from (40) and (41). Implicit marginal costs for Florida and the tariff-inclusive implicit marginal costs for Mexico are given respectively by

$$C_u' = P - b_1 q_u \tag{42}$$

and

$$C_m' + T = P - c_1 q_m. \tag{43}$$

The Estimated Model

The inverse market demand for fresh tomatoes is specified as a function (linear in the parameters) of the total quantity of fresh tomatoes traded by Florida and Mexico at the shipping-point, per capita GNP, and the price of green peppers received by growers in Florida. The green pepper price enters on its own as well as in interaction with total quantity. The interaction term satisfies the comparative static requirement for identification of the conjectural elasticity, one component of the measure of oligopoly power, namely, that the demand curve rotate as shifts in the intercept occur (Bresnahan, 1982; Lau, 1982). The price of green peppers was used because this commodity is conceivably related in demand to fresh tomatoes either as a complementary or substitute product. Changes in the green pepper price can affect the location and slope of the demand schedule. Other price variables (e.g., lettuce, cucumbers) can serve the same purpose as the green pepper price in this analysis. Their use may change the values of the empirical estimates but the qualitative results should remain unchanged.

The supply relations for both Florida and Mexico are specified in inverse form as linear functions of the respective quantities and appropriate exogenous variables, in particular, variables which influence marginal costs. The generalized inverse supply relation for Florida is specified as a function of the quantity of fresh tomatoes supplied by Florida, the daily wage rate, the US interest rate (index), the occurrence of a freeze in Florida and a time trend. The generalized inverse supply relation for Mexico is specified as a function of the quantity supplied by Mexico, the Mexican daily wage rate, the specific tariff on imports of Mexican fresh tomatoes, the occurrence of a freeze in Florida, the exchange rate and lagged price.

The time trend is included in the Florida equation to capture technical change. Previous research (Bredahl et al., 1983; Kalaitzandonakes and Taylor, 1990; Tefertiller and Ward, 1995) indicated that significant technical change had taken place in the fresh vegetable industry in Florida. In a recent article, Tefertiller and Ward show that fresh tomato production in Florida increased over 5% annually due to improved yields and structural changes. They conclude that most of this increase came from technical change. Freeze variables are included in both the Florida and Mexican supply relations because the occurrence of freezes have been known to lead to large price increases and influences supplies from both areas. A freeze would also have implications for costs as the supplies of both areas are affected. It is assumed that Mexico adjusts price to achieve a certain degree of price stability. Previous research suggests that price stability was the major motivation behind the export restraint policy practiced by Mexico since the early

1970s. The first lag of price is included in the Mexican equation to capture this adjustment.

The following system of equations was estimated:

$$P = a_0 + a_1 Q + a_2 \frac{GNP}{POP} + a_3 GPP + a_4 (Q * GPP) + u1 \tag{44}$$

$$P = b_0 + b_1 q_a + b_2 w_{ul} L + b_3 w_{ul} + b_4 F + b_5 time + u_2 \tag{45}$$

$$P = c_0 + c_1 q_m + c_2 w_{ml} + c_3 T + c_4 F + c_5 EXC + c_6 P_{t-1} + u_3 \tag{46}$$

where (44)-(46) are market demand, and Florida and Mexican supply relations respectively. P is price expressed in current terms, Q is total quantity, q_a is Florida quantity, q_m is Mexico's quantity, GNP is US gross national product in current dollars, GPP is the price in current terms for green peppers received by growers in Florida. The daily wage rate for Florida is represented by w_{ul}; w_{ul} is the interest rate index for Florida, F represents the occurrence of a freeze, w_{ml} is the daily wage rate (minimum wage) for Mexico, T is a specific import tariff; EXC is the annual US/Mexico exchange rate expressed in pesos per US dollar, P_{t-1} is the first lag of the current price, and u_{1t}, u_{2t} and u_{3t} are appropriate error terms. The structural disturbances are assumed to be randomly drawn from an M-variate distribution with mean zero, a non-singular co-variance matrix and $E[u_t u_s'] = 0$ for all $t \neq s$ where M is the number of equations in the system (Greene, 1990).

The above system of equations is identified econometrically; both order and rank conditions are satisfied. The endogenous variables in the model are price (P), total

quantity (Q), Florida quantity (q_{fl}), Mexican quantity (q_{mx}), and the interaction term of total quantity and the green pepper price, (Q*GPP). Overall, the system is overidentified which indicates that there is more information than is required to estimate the parameters of the system. An estimation procedure which takes advantage of this information should be employed. A system estimator is appropriate. The demand equation includes an interaction term involving an endogenous variable which makes the interaction term itself endogenous. The usual approach to identification has to be modified. This is handled by counting the interaction term as an endogenous variable without increasing the number of equations and applying the usual rank condition, rank[A'Φ]=M-1, where A' is the (augmented) matrix of coefficients (Greene, 1990). Estimation was accomplished using (nonlinear) three-stage least squares. The instrumental variables were the constant terms and all the exogenous variables in the system (namely, per capita GNP, the green pepper price, wage rates in Florida and Mexico, the interest rate index, the freeze variable, time, the import tariff, the exchange rate and lagged price).

Data

Annual FOB shipping-point prices and quantities, covering the months January to April and expressed on a 25-lb basis, were used in the analysis. Annual quantities for Florida and Mexico were given by the sum of the monthly quantities for January through April. The prices for all fresh tomato supplies to the US winter market (as defined in this study) were derived as weighted averages of prices received by producers in Florida and Mexico with the respective "annual" quantities as weights. Previous conclusions about the existence of market integration (Jordan and VanSickle, 1995) indicate that a

single price represents a reasonable assumption which should adequately capture the conditions on the market. Data sources include various issues of Marketing Mexico Fruits and Vegetables and Marketing Florida Vegetables, both published by US Department of Agriculture; various issues of the Vegetable Summary published by the Florida Agricultural Statistics Service (FASS); and the Annual Reports of the Florida Tomato Committee.

The time series for the price of green peppers was taken from the Vegetable Summary. Income in the demand equation is represented by per capita GNP. GNP data was divided by total U.S. population to derive per capita GNP. Both GNP and population data were taken from the International Financial Statistics published by the International Monetary Fund (IMF). Basic tariff rates on imports of fresh tomatoes were taken from Agriculture in the North American Free Trade Agreement (1993) published by the Congressional Budget Office (Congress of the United States). These are 3.3 cents per kg. for January and February and 4.6 cents for March and April. Using these basic rates, average annual tariff rates were computed with monthly shipments by Mexico used as weights. Like prices and quantities, tariff rates were expressed on a 25-lb basis. The occurrence of freezes in Florida is represented by a binary variable. The information on freezes was taken from Marketing Florida Vegetables, Marketing Mexico Fruits and Vegetables, and the Vegetable Summary. Seasons in which significant freezes occurred were 1977, 1981, 1982, 1984, 1985, 1989 and 1990.

The cost of capital paid by producers in Florida is represented by a US national interest rate index taken from various issues of Agricultural Statistics published by the

USDA. Annual exchange rates were taken from International Financial Statistics published by the IMF. Figures represent the period averages of the market and official exchange rates. The minimum daily wage expressed in terms of US dollars per day is used to represent labor wages in the case of Mexico. These data were taken from VanSickle et al. (1994). Wage rates for Florida were taken from various issues of Agricultural Statistics. The data used in the analysis is presented in the Appendix.

Empirical Estimation of Policy Preference Weights

On the assumption that the US government chooses the tariff to maximize national welfare, the optimal condition for the government's problem is given by (27). This equation can be re-arranged as follows:

$$T^{*}=-\frac{q_{m}}{g\dfrac{dq_{u}}{dT}}+\frac{\alpha}{\delta}\frac{Q\dfrac{dP}{dT}}{g\dfrac{dq_{u}}{dT}}-\frac{\beta}{\delta}\frac{(P-C_{u}^{\prime})}{(1+r_{um})}\frac{[r_{um}-g]}{g} \tag{47}$$

where T^{*} is the optimal tariff. Expressions for (dq_u/dT), (dP/dT) and g can be obtained from an examination of the comparative static effects. Total differentiation of the first-order conditions for the industries yields the following:

$$\begin{bmatrix} P^{\prime}(2+r_{um})+P^{\prime\prime}q_{u}(1+r_{um})-C_{u}^{\prime\prime} & P^{\prime}+P^{\prime\prime}q_{u}(1+r_{um}) \\ P^{\prime}+P^{\prime\prime}q_{m}(1+r_{mu}) & P^{\prime}(2+r_{mu})+P^{\prime\prime}q_{m}(1+r_{mu})-C_{m}^{\prime\prime} \end{bmatrix}\begin{bmatrix} dq_{u} \\ dq_{m} \end{bmatrix}=\begin{bmatrix} 0 \\ dT \end{bmatrix} \tag{48}$$

where

This system of equations can be solved for dq_u and dq_m as follows:

$$\begin{bmatrix} P'(2+r_{um})+P''q_u(1+r_{um})-C_u'' & P'+P''q_u(1+r_{um}) \\ P'+P''q_m(1+r_{mu}) & P'(2+r_{mu})+P''q_m(1+r_{mu})-C_m'' \end{bmatrix}=H\ ; \tag{49}$$

$$dq_u=\frac{\begin{bmatrix} 0 & P'+P''q_u(1+r_{um}) \\ dT & P'(2+r_{mu})+P''q_m(1+r_{mu}-C_m'' \end{bmatrix}}{\det H}; \tag{50}$$

and

$$dq_m=\frac{\begin{bmatrix} P'(2+r_{um})+P''q_u(1+r_{um})-C_u'' & 0 \\ P'+P''q_m(1+r_{mu}) & dT \end{bmatrix}}{\det H}. \tag{51}$$

From expressions (50)-(51), dq_u/dT, $dq_m/dq_u=g$ and dP/dT can be derived as follows:

$$\frac{dq_u}{dT}=-\frac{\left[P'+P''q_u(1+r_{um})\right]}{\det H}>0; \tag{52}$$

$$\frac{dq_m}{dq_u}=g=\frac{\left[P'(2+r_{um})+P''q_u(1+r_{um})-C_u''\right]}{-\left[P'+P''q_m(1+r_{mu})\right]}<0; \tag{53}$$

and

$$\frac{dP}{dT}=P'\frac{dQ}{dT}=\frac{P'(dq_u+dq_m)}{dT}>0. \tag{54}$$

The empirical estimation of the policy preference weights must be premised on the estimation of the demand equation and the supply relations and, specifically, the estimation of the conjectural variations for the respective industries. Given the empirical

specification of a demand function linear in the parameters and on the assumption of constant marginal costs, then $P''=0$ and $C''=0$. This implies that (51) and (52) can be re-written as

$$\frac{dq_u}{dT}=\frac{-P'}{[(P')^2(2+r_{um})(2+r_{mu})-(P')^2]} \tag{55}$$

and

$$\frac{dq_m}{dq_u}=g=\frac{P'(2+r_{um})}{-P'}. \tag{56}$$

It can be shown that dP/dT is equal to the slope of the Florida supply relation, b_1 times dq_u/dT.

Having found values for dq_u/dT, g and dP/dT, these can be substituted into (47). At this point all values in (47) are known except for the parameters α, β and δ. When $\alpha=\beta=\delta=1$, the welfare function (14) is unweighted and producers, consumers and tariff revenue all receive equal emphasis. The assumption can be made that the tariff revenue is re-distributed in a equal manner between producers and consumers. This allows one to focus on the distributional impact of policy and facilitates the estimation of the policy preference weights attached to producers and consumers. The relationship among the weights are specified as follows:

$$\alpha+\beta+\delta=3; \quad \delta=1 \tag{57}$$

Equations (47) and (56) can be solved simultaneously for the empirical values of the policy preference weights for each year.

The solution for the weights was obtained using a static simulation. The SIML procedure in TSP (Hall et al., 1987), which solves linear and nonlinear simultaneous equations models using Newton's method with an analytic Jacobian, was used. The model was solved period by period over the current sample. The criterion function for SIML is the sum of the squared deviations of the equations. In the simulation, the weights α and β were expressed in terms of δ since only relative weights are of interest. This meant that there were two equations in two unknowns and therefore it was possible to find solutions for the weights.

Empirical Results

The parameter estimates of the structural model and their statistical significance are presented in table 1. The estimates on all the explanatory variables in the demand equation are statistically significant at the 5% level. The demand curve is downward-sloping, i.e., the sign of the coefficient on total quantity is negative, indicating that the quantity demanded falls with an increase in price. The coefficient on per capita income is positive suggesting that the price level tends to rise as income increases. An increase in income indicates an outward shift in demand at given prices. The direct effect of a change in the price of green peppers on the tomato price is positive. This supports the existence of a complementary relationship between fresh tomatoes and green peppers. However, this positive effect is dampened by the negative influence of the interaction term on price. The interaction term affects price inversely, modifying the slope of the

demand curve. The slope of the demand curve becomes more negative with increases in the green pepper price. This implies that as the price of green peppers rises, given the relationship between the commodities is complementary, the quantity of tomatoes demanded falls.

In the Florida supply equation, all the explanatory variables represent statistically significant influences on price at the 5% level. The positive coefficient on quantity indicates an upward-sloping supply relation. Wage rates in Florida are positively related to the price of fresh tomatoes; price rises in response to increases in the wage rate. The interest rate index is negatively related to price. This is not consistent with expectations. An increase in the interest rate (cost of capital) raises marginal costs, ceteris paribus, and should therefore lead to a higher price. Some other factor may be overwhelming this expected relationship, most probably productivity growth in the fresh tomato industry. A freeze in Florida causes a price rise due to reduced supplies and market uncertainty. The coefficient on the time trend is negative indicating that Florida's asking price tended to fall over time. This is consistent with the technical change which is known to have taken place in the Florida industry (Bredahl et al., 1983; Kalaitzandonakes and Taylor, 1990; Tefertiller and Ward, 1995). Technical change would tend to make fresh tomatoes cheaper as marginal costs decline.

The coefficient on quantity in the Mexican supply equation was positive but not statistically significant at the 5% level; statistical significance is indicated at the 15% level. The coefficient on wage rates was positive and significant indicating that prices rise with wage rate increases. This was in keeping with expectations since marginal cost

Table 1. Parameter Estimates for the Structural Model

Variables	Demand	Florida Supply	Mexico Supply
Constant	5.94 (4.30)[a]	-4.98* (2.46)	4.82 (12.58)
Q	-0.24E-06* (0.13E-06)		
GNP/POP	0.71* (0.05)		
GPP	1.49* (0.61)		
Q*GPP	-0.40E-07* (0.15E-07)		
q_{fa}		0.36E-06* (0.12E-06)	
w_{ul}		0.78* (0.22)	
w_{ui}		-0.03* (0.97E-02)	
F		3.70* (0.94)	1.92* (0.76)
TIME		-1.13* (0.34)	
q_{fm}			0.17E-06[b] (0.16E-06)
w_{ml}			1.19* (0.50)
T			-12.06 (27.23)
EXC			0.20E-02* (0.68E-03)
P_{t-1}			-0.26[c] (0.17)
R^2	0.95	0.65	0.64
D.W.	2.66	2.77	n.a.

* Estimate is statistically significant at the 5% level of significance.

[a] Standard errors are in parentheses.

[b] Estimate is statistically significant at the 15% level of significance.

[c] Estimate is statistically significant at the 10% level of significance.

increases as a result of wage rate increases, thereby increasing price. Price also increased whenever a freeze occurred in Florida. The exchange rate was also statistically significant and positively related to price. This is consistent with expectations since increases in the exchange rate increases price to Mexican producers and price rises lead to increased supply. Positive coefficients on quantity and the exchange rate were therefore anticipated. Lagged price was statistically significant at the 10% level and carried the expected negative sign. High prices in the previous period would tend to lead to a lower current price. This lends support to the notion that price stability was a critical issue for Mexico. The tariff rate was not statistically significant at any reasonable level of significance. This is not surprising since basic tariff rates have not changed for a considerable time; current tariffs have been unchanged since 1951.

Based on the estimated parameters of the structural model, the demand elasticity, conjectural variations, conjectural elasticities, measures of oligopoly power and implicit marginal costs (MC's) were computed. These are shown in Tables 2-6 for the entire sample period along with their mean values.

Price Elasticity of Demand

The estimated values of the price elasticity of demand suggest that demand for fresh tomatoes at the shipping-point during the winter period (January-April) was inelastic. The mean value of the demand elasticity was -0.41 and was statistically significant at the 5% level for every year as well as when evaluated at the mean. The more inelastic is the demand, the greater the ability of the producers to exercise market

power. Demand tended to become less inelastic in the years in which freezes occurred in Florida as quantities declined and prices rose. This would be expected given the linearity of the estimated demand functions. The years 1977, 1981 and 1990 in which freezes occurred in Florida were noteworthy in this regard. Also significant was the year 1992 in which the supply from Mexico was reduced due to adverse weather. The estimated values of the demand elasticity along with standard errors are given in Table 2 and a time series plot is shown in Figure 3.

Conjectural Variations

The conjectural variations indicate what one set of suppliers anticipate the other's response will be if the former were to change its quantity. The estimated values for both industries were negative indicating that an increase in quantity by any one industry was expected to lead to a reduction in the other's supply. The estimated conjectural variations for Florida suggested that its behavior was not competitive. Competitive behavior requires a conjectural variation of -1. The estimated conjectural variations for Florida, evaluated at the mean, was statistically different from -1 at the 5% level. Mexico's behavior was not statistically inconsistent with competition at the 5% level. It was, however, inconsistent with competitive behavior at the 15% level. Over the entire period, Mexico's behavior was apparently more competitive than Florida's. There was a slight trend towards greater competition on the part of both Florida and Mexico over time as the estimated conjectures became more negative. The mean values for the conjectural variations of Florida and Mexico respectively are -0.29 and -0.65. The corresponding standard errors 0.27 and 0.32. The estimated conjectural variations

Table 2. Demand Elasticity Estimates(η)

Year	η	Std. Error
1971	-0.50	0.09
1972	-0.33	0.06
1973	-0.31	0.05
1974	-0.46	0.06
1975	-0.39	0.05
1976	-0.38	0.05
1977	-0.59	0.07
1978	-0.37	0.05
1979	-0.41	0.04
1980	-0.26	0.02
1981	-0.65	0.05
1982	-0.37	0.03
1983	-0.38	0.03
1984	-0.39	0.03
1985	-0.45	0.04
1986	-0.28	0.02
1987	-0.19	0.02
1988	-0.29	0.03
1989	-0.43	0.04
1990	-0.66	0.05
1991	-0.25	0.02
1992	-0.64	0.05
Mean	-0.41	0.05

together with standard errors are given in Table 3 and time series plots are shown in Figure 4.

Conjectural Elasticities

Several tests of hypotheses were conducted on the conjectural elasticities for Florida and Mexico. These provide insight into the underlying market structure and also

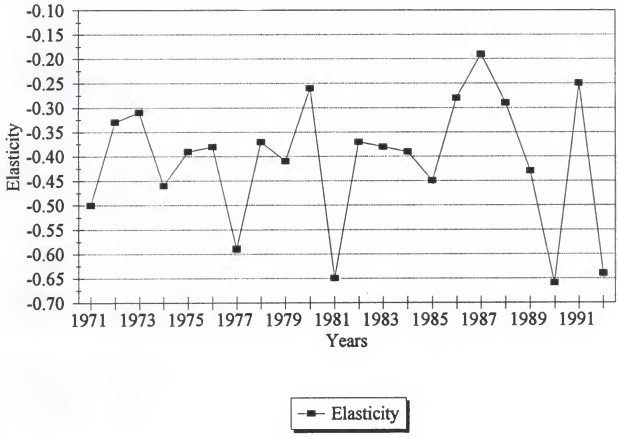

Figure 3. Price Elasticity of Demand

Table 3. Estimated Conjectural Variations (r_{um}, r_{mu})

Year	r_{um}	Std. Error	r_{mu}	Std. Error
1971	-0.10	0.38	-0.56	0.39
1972	-0.12	0.37	-0.57	0.38
1973	-0.12	0.37	-0.57	0.38
1974	-0.18	0.32	-0.60	0.35
1975	-0.19	0.32	-0.60	0.35
1976	-0.22	0.30	-0.62	0.34
1977	-0.24	0.29	-0.63	0.33
1978	-0.20	0.31	-0.61	0.35
1979	-0.27	0.27	-0.64	0.32
1980	-0.32	0.24	-0.67	0.30
1981	-0.37	0.22	-0.69	0.28
1982	-0.32	0.25	-0.67	0.30
1983	-0.43	0.20	-0.72	0.26
1984	-0.35	0.23	-0.68	0.29
1985	-0.29	0.26	-0.66	0.31
1986	-0.32	0.25	-0.66	0.31
1987	-0.51	0.17	-0.76	0.22
1988	-0.28	0.27	-0.65	0.32
1989	-0.32	0.25	-0.67	0.30
1990	-0.34	0.24	-0.68	0.29
1991	-0.47	0.18	-0.74	0.24
1992	-0.39	0.22	-0.70	0.27
Mean	-0.29	0.27	-0.65	0.32

about the degree of market power held by the respective industries. First, the conjectural elasticities were each evaluated to establish if they were statistically different from zero. This facilitates conclusions being made about the degree of market power held separately by Florida and Mexico since the elasticity is the same for both supplying areas. These tests were evaluated at the mean and done using asymptotic t-statistics. Second, the

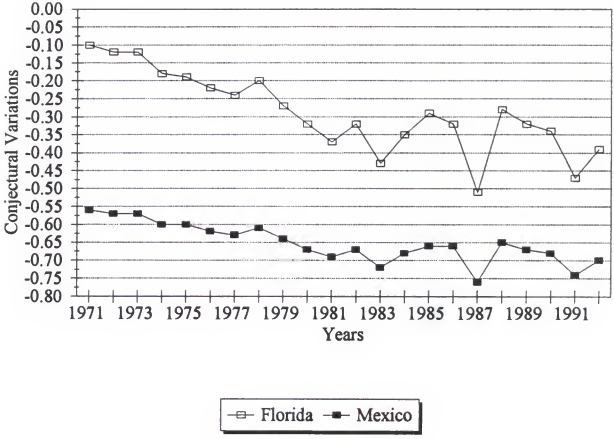

Figure 4. Conjectural Variations

conjectural elasticities were compared on the basis of a Chi-squared statistic with one degree of freedom to determine whether they were statistically different from each other. This allows a more definitive conclusion to be made about the relative market power held by Florida and Mexico. Third, the sum of the conjectural elasticities were compared to the hypothesized sums of zero for perfect competition; one for Cournot behavior; and two for collusion. These tests facilitate the characterization of the structure of the entire market. They were conducted on the basis of a chi-squared test statistic with one degree of freedom. The estimated conjectural elasticities along with asymptotic standard errors are given in table 4 and time series plots are shown in Figure 5. Calculated chi-squared statistics used for the evaluation of equality of the conjectural elasticities and for the consistency of their sum with the hypotheses of perfect competition, Cournot behavior and collusion are given in Table 5.

The theoretical value for the conjectural elasticity ranges from zero to one. A conjectural elasticity of zero is indicative of perfect competition while a value of one suggests monopolistic behavior. The mean values for Florida and Mexico are 0.32 and 0.19 with standard errors of 0.12 and 0.18 respectively. The value for Florida is statistically different from zero at the 5% level while that for Mexico is significant at the 15% level. The estimated conjectural elasticities for Florida and Mexico suggest the presence of non-competitive elements in the behavior of both suppliers with this being apparently more pronounced in the case of the former. Market shares are an important influence on the conjectural elasticities. There was some evidence (1977, 1990) that

Table 4. Estimated Conjectural Elasticities (θ_u, θ_m)

Year	θ_u	Std. Error	θ_m	Std. Error
1971	0.30	0.13	0.29	0.26
1972	0.33	0.14	0.27	0.24
1973	0.24	0.10	0.31	0.27
1974	0.31	0.12	0.25	0.22
1975	0.39	0.16	0.20	0.18
1976	0.34	0.13	0.21	0.19
1977	0.16	0.06	0.30	0.26
1978	0.22	0.08	0.28	0.25
1979	0.29	0.11	0.22	0.19
1980	0.31	0.11	0.18	0.16
1981	0.29	0.10	0.17	0.15
1982	0.36	0.13	0.16	0.14
1983	0.30	0.10	0.14	0.13
1984	0.29	0.10	0.17	0.16
1985	0.31	0.11	0.20	0.18
1986	0.33	0.12	0.18	0.16
1987	0.24	0.08	0.13	0.12
1988	0.43	0.16	0.14	0.13
1989	0.44	0.16	0.12	0.11
1990	0.32	0.11	0.17	0.15
1991	0.30	0.10	0.11	0.10
1992	0.51	0.18	0.05	0.05
Mean	0.32	0.12	0.19	0.18

Florida's conjectural elasticity tended to decline and that of Mexico tended to increase in the years when supplies were reduced due to the occurrence of a freeze. This is consistent with the finding by VanSickle et al. (1994) that, in times of freezes, Florida would lose the weighted price advantage.

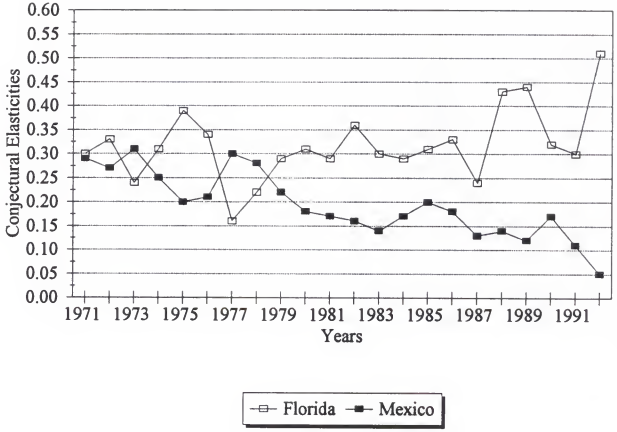

Figure 5. Conjectural Elasticities

Examination of the values for the conjectural elasticities reveals that there was apparently a greater "battle" for dominance in the market in the period up to 1978. The conjectural elasticity for Mexico was greater than Florida's in three of the first eight years. The time series plots in Figure 5 indicate that the estimated conjectural elasticities for Florida and Mexico crossed several times before 1978. In the early 1970s, Mexico had the comparative advantage (Bredahl et al., 1983). In 1978 and again in 1979, Florida filed anti-dumping petitions against Mexico. It is clear that the increase in Mexico's influence on the market would have been a motivating factor behind such action. Florida would have witnessed increases in Mexican market share in response to adverse weather in Florida in 1976 and 1977. After 1978, there was a clear upward trend in Florida's conjectural elasticity ending with a value of 0.51 in 1992. On the other hand, Mexico's conjectural elasticity displayed a declining trend after 1978. Florida was evidently gaining market power relative to Mexico. This is consistent with the conclusions by Bredahl et al. (1983) that Florida was able to gain the market advantage as a result of technical change in the industry. In addition, the adoption of a supply restraint policy by Mexico against a background of wider US-Mexico relations may have contributed to this picture.

Although the respective estimated conjectural elasticities suggested deviations from competitive behavior on the part of both Florida and Mexico with Florida perhaps having the advantage, the hypothesis of equality of the conjectural elasticities, i.e., $\theta_u=\theta_m$, could not be rejected. This was true for every year of the period under review except 1992 and also when evaluated at the mean. Therefore, the conclusion can be

made that the market power exercised by Florida was not statistically different from that held by Mexico.

Table 5. χ^2-Statistics for Hypotheses About the Conjectural Elasticities

Year	Equality $H_0:\theta_u=\theta_m$	Competition $H_0:\theta_u+\theta_m=0$	Cournot $H_0:\theta_u+\theta_m=1$	Collusion $H_0:\theta_u+\theta_m=2$
1971	0.25E-03	5.39*	2.57	30.56*
1972	0.46E-01	6.42*	2.82	34.67*
1973	0.43E-01	4.42*	2.88	30.24*
1974	0.55E-01	6.82*	4.27*	45.51*
1975	0.46	9.16*	4.18*	50.64*
1976	0.23	8.37*	5.47*	57.35*
1977	0.23	3.28	4.79*	38.28*
1978	0.55E-01	4.39*	4.42*	39.67*
1979	0.84E-01	7.41*	7.13*	65.00*
1980	0.34	9.38*	10.19*	89.29*
1981	0.33	9.31*	13.36*	107.36*
1982	0.83	11.26*	9.68*	91.75*
1983	0.73	10.94*	18.92*	144.18*
1984	0.29	9.07*	12.11*	99.46*
1985	0.21	8.51*	8.47*	76.27*
1986	0.40	9.64*	9.29*	84.64*
1987	0.48	9.30*	28.96*	190.83*
1988	1.48	11.94*	6.57*	73.64*
1989	2.13	12.67*	7.82*	83.76*
1990	0.47	10.07*	11.52*	99.22*
1991	1.21	11.97*	24.73*	179.71*
1992	5.14*	11.38*	7.10*	75.75*
Mean	0.39	9.62*	9.15*	83.75*

* Estimate is statistically significant at the 5% level of significance.

The tests of hypotheses on the sum of the conjectural elasticities were conducted at the means and also for every year of the analysis. Evaluation at the means revealed that perfect competition, Cournot behavior and collusion all could not be supported at the

5% level. Competition was rejected for every year except 1977, Cournot behavior could not be rejected only in the years 1971-73, and collusion was consistently rejected over the period of analysis. It can therefore be concluded that the market was not competitive and that some degree of market power was held by Florida and Mexico.

Degree of Oligopoly (Market) Power

The degree of oligopoly power is a product of the conjectural elasticity and the (negative of the) inverse demand elasticity. This facilitates the separation of market power into supply-side effects due to the conjectural elasticity and the demand side effects due to the demand elasticity. An increase in the demand elasticity (or a fall in the inverse demand elasticity) leads to a fall in market power. Like the conjectural elasticity, the degree of oligopoly power should lie between zero and one (Appelbaum,1982).

Tests of hypotheses were conducted to establish whether the measures of oligopoly power were statistically different from zero and different from each other. The former set of tests was done on the basis of asymptotic t-statistics while the latter was done using a chi-squared statistic. The mean values for the degree of oligopoly (market) power for Florida and Mexico were 0.85 and 0.51 with standard errors of 0.31 and 0.51 respectively. The value for Florida is statistically significant from zero at the 5% level. Statistical significance is indicated for Mexico at the 15% level. It can be concluded that both Florida and Mexico possessed significant market power. The value of the oligopoly power measure was generally higher for Florida than for Mexico. However, a considerable amount of market power came from the demand side due to an inelastic

demand. In several years, the computed value of the oligopoly power measure for Florida was greater than one. However, these values were not different from one statistically. The basic patterns evident in the case of the conjectural elasticities are also

Table 6. Estimated Measures of Oligopoly Power ($\theta_u\epsilon$,$\theta_m\epsilon$)

Year	$\theta_u\epsilon$	Std. Error	$\theta_m\epsilon$	Std. Error
1971	0.59	0.20	0.58	0.54
1972	1.02	0.35	0.82	0.76
1973	0.78	0.27	1.00	0.92
1974	0.68	0.24	0.54	0.50
1975	1.00	0.34	0.52	0.48
1976	0.88	0.30	0.56	0.51
1977	0.26	0.09	0.50	0.46
1978	0.58	0.20	0.76	0.70
1979	0.71	0.25	0.53	0.49
1980	1.18	0.41	0.68	0.62
1981	0.44	0.15	0.26	0.24
1982	0.98	0.34	0.43	0.39
1983	0.78	0.27	0.36	0.33
1984	0.73	0.25	0.44	0.41
1985	0.68	0.24	0.44	0.40
1986	1.15	0.40	0.63	0.58
1987	1.25	0.43	0.66	0.61
1988	1.46	0.50	0.48	0.45
1989	1.02	0.35	0.27	0.25
1990	0.48	0.17	0.25	0.23
1991	1.20	0.41	0.46	0.42
1992	0.79	0.27	0.08	0.08
Mean	0.85	0.31	0.51	0.51

noted with respect to the oligopoly power measures, namely, that dominance in the market appeared to change hands in the period up to 1978 and a generally increasing

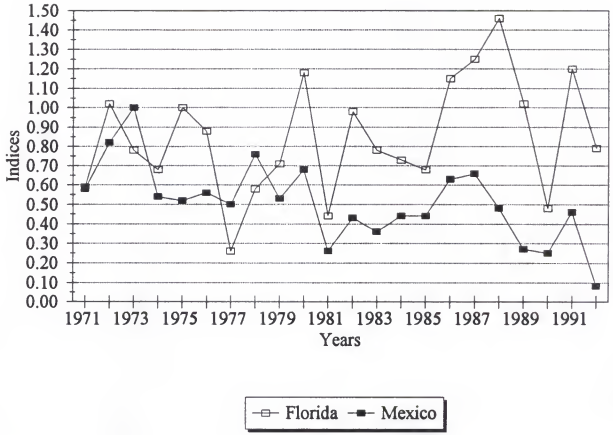

figure 6. Oligopoly Power Indices

trend for Florida and a generally declining trend for Mexico after 1978. The estimates of the degree of oligopoly power along with standard errors are given in Table 6 while Figure 6 shows the corresponding time series plots. As was the case with the conjectural elasticities, the hypothesis of equality of the oligopoly power measures, i.e., $\theta_u\epsilon=\theta_m\epsilon$, could not be rejected at the 5% level of significance on the basis of a chi-squared test statistic. When evaluated at the mean, the calculated statistic with one degree of freedom was 0.41 compared with a critical value of 3.84. This confirms the conclusion arrived at with respect to the conjectural elasticities, namely, that the market power exercised by Florida was not statistically different from that held by Mexico.

Implicit Marginal Costs

Florida's marginal cost was lower than Mexico's on average. The mean value of the implicit marginal cost for Florida was 1.37 with standard error of 2.20 while that for Mexico was 4.04 with standard error of 3.08. This disparity in marginal costs was anticipated given the reported higher productivity in Florida and the higher marketing and transportation costs incurred by Mexico. While Florida's marginal cost showed no particular trend, an upward trend was exhibited by Mexican marginal cost. Marginal cost tended to jump in freeze years for both suppliers. In several years, the estimated marginal costs for Florida were negative. None of these were statistically significant at any reasonable level. However, negative marginal costs signifying a fall in average costs between years may derive from increases in productivity. The implicit marginal costs for Florida and Mexico together with standard errors are given in Table 7 and the corresponding time series plots are shown in Figure 7.

Table 7. Implicit Marginal Costs (MC_u, MC_m)

Year	MC_u	Std. Error	MC_m	Std. Error
1971	2.00	1.00	2.05	2.63
1972	-0.09	1.44	0.74	3.09
1973	0.87	1.08	0.02	3.67
1974	1.82	1.36	2.66	2.88
1975	0.00	1.79	2.48	2.50
1976	0.63	1.65	2.41	2.77
1977	5.76	0.71	3.93	3.59
1978	2.46	1.17	1.39	4.13
1979	1.94	1.65	3.15	3.29
1980	-0.90	2.03	1.62	3.11
1981	6.19	1.68	8.24	2.61
1982	0.13	2.27	3.87	2.64
1983	1.89	2.33	5.54	2.87
1984	2.14	2.05	4.52	3.28
1985	2.80	2.08	4.96	3.57
1986	-0.95	2.49	2.30	3.67
1987	-1.45	2.51	1.98	3.56
1988	-3.06	3.32	3.40	2.93
1989	-0.18	3.31	6.87	2.37
1990	6.89	2.20	9.93	3.09
1991	-1.52	3.15	4.15	3.20
1992	2.82	3.76	12.58	1.07
Mean	1.37	2.20	4.04	3.08

Policy Preference Weights

Policy preference weights were computed on the assumption that the US government was implementing an optimal tariff. Before obtaining the empirical values

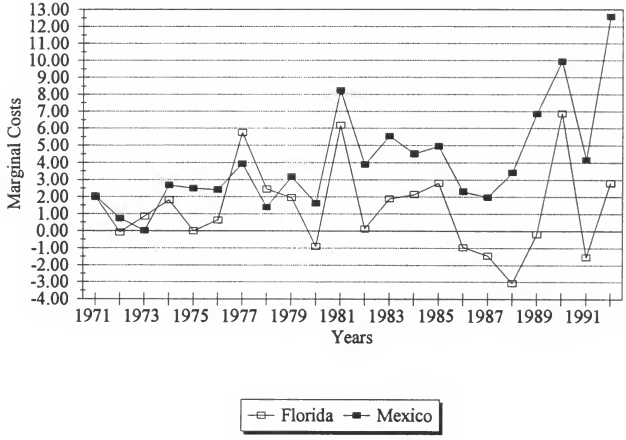

Figure 7. Implicit Marginal Costs

for the weights, however, it was necessary to estimate dq_m/dT, dP/dT and g. The expected signs were positive, positive (but less than one) and negative respectively. This indicates that an import tariff will lead to increases in Florida's supply. The tariff will also lead to increases in the price but not by the full amount of the tariff because consumers will reduce their demand. The negative sign on g shows that Florida's quantity is inversely related to Mexico's. This is consistent with an earlier finding by Shonkwiler and Emerson (1982). All the empirical values and signs conformed with expectations. An evaluation of the disparity between Florida's conjectural variation (r_{mm}) and the realized Mexican response to a quantity change by Florida, g, provides information on the consistency of Florida's conjectures, i.e., on the extent to which Florida gauged Mexico's behavior correctly.

The empirical values for the policy preference weights are given in Table 8. The weight attached to producers was higher than that for consumers for every year over the sample period with the exception of 1992. However, though the movement of the weights was somewhat erratic, the weight attached to producer's surplus tended to decline, while that attached to consumer's surplus tended to rise. The trend towards increased weight being put on consumer's surplus will undoubtedly have something to do with the fact that, since the 1970s, the interests of consumers have been more cogently articulated in the wider economy with many groups representing the interests of consumers. However, it can be more specifically explained partly by increased supplies due to productivity gains particularly in the Florida industry. Another contributory factor may be the declining effectiveness of the tariff as a means of

protection. The real value of the tariff, i.e., the tariff deflated by the US consumer price index (CPI), fell consistently from \$0.70 per 25 pounds in 1971 to \$0.19 in 1992 while the tariff expressed as a percentage of the price declined consistently from an average of

Table 8. Policy Preference Weights on Consumers and Producers

Year	Consumers' Surplus	Producers' Surplus
1971	-0.04	2.04
1972	0.14	1.86
1973	-0.23	2.23
1974	0.16	1.84
1975	0.45	1.55
1976	0.33	1.67
1977	-0.52	2.52
1978	-0.23	2.23
1979	0.22	1.78
1980	0.42	1.58
1981	0.41	1.59
1982	0.58	1.42
1983	0.56	1.44
1984	0.39	1.61
1985	0.34	1.66
1986	0.44	1.56
1987	0.50	1.50
1988	0.73	1.27
1989	0.82	1.18
1990	0.48	1.52
1991	0.68	1.32
1992	1.10	0.90

10% in 1971-73 to 4% in 1990-92. Some of the estimated weights on consumer surplus were negative in the 1970s. Given the assumption that the tariff revenue was distributed

equally between producers and consumers, these negative values imply that consumers were effectively being taxed to support producers.

The computed weights in this analysis are generally consistent with the picture in which consumers were becoming more important in the policy process. It appeared that consumers were adversely affected when the quantities supplied were reduced in the instance of a freeze (e.g., in 1977 and 1990) as total quantity fell and price rose. The results are consistent with those of Oehmke and Yao (1990) who found that consumers had less influence than producers in the policy process as it related to the wheat sector but their influence had increased by 1985 relative to 1977. Agricultural producers, in general, are reported to have lost political power relative to consumers in the late 1970s and early 1980s.

Table 9 compares Florida's conjectural variation (r_{um}) and the realized Mexican response to changes in Florida's quantities, g. This indicates that conjectures have not been consistent. Consistent conjectures imply that the conjectured and realized responses must be equal. The conjectured response was significantly different from the actual response at the 5% level of significance in every year over the sample period based on a chi-squared statistic with one degree of freedom. Calculated chi-squared values ranged from 5.54 to 8.74. Comparing the calculated values with the critical value of 3.84 indicates that the hypothesis $r_{um}=g$ (i.e., that the conjectured and realized responses are equal could not be supported.

The difference, r_{um} - g, was consistently positive, indicating that conjectures were not consistent. Florida's conjecture indicates the amount by which Florida expects

Mexico will change its quantity in response to a quantity change by Florida. The estimated conjecture was negative indicating that Florida expected that Mexico would reduce its quantity if the former increased its quantity. Mexico, in fact, did reduce its quantity but by more than anticipated by Florida. The tariff has the effect of raising

Table 9. Florida's Conjecture (r_{um}) and Mexico's Response (g)

Year	r_{um}	g
1971	-0.10	-1.90
1972	-0.12	-1.88
1973	-0.12	-1.88
1974	-0.18	-1.82
1975	-0.19	-1.81
1976	-0.22	-1.78
1977	-0.24	-1.76
1978	-0.20	-1.80
1979	-0.27	-1.73
1980	-0.32	-1.68
1981	-0.37	-1.63
1982	-0.32	-1.68
1983	-0.43	-1.57
1984	-0.35	-1.65
1985	-0.29	-1.71
1986	-0.32	-1.69
1987	-0.51	-1.49
1988	-0.28	-1.72
1989	-0.32	-1.68
1990	-0.34	-1.66
1991	-0.47	-1.53
1992	-0.39	-1.61
Mean	-0.29	-1.71

Florida's output above the level it would be in the absence of this policy. Mexico responds by reducing its output by more than anticipated by Florida. This means that there was less total supply on the market than was foreseen by Florida. It has the effect

of raising the price over the level projected by Florida, benefitting Florida's producers as a result of higher output and higher price than in the absence of the import tariff. Mexico's behavior might be explained to some extent by the inelastic nature of demand. With an inelastic demand, small reductions in the quantity lead to large price increases and, therefore from the standpoint of total revenue, quantity reductions would have been beneficial.

Florida's conjecture proved not to be consistent with the actual slope of Mexico's reaction function. Mexico would always cut back its supply by more than was anticipated by Florida. However, both supply areas benefitted from this, given an inelastic demand. From a policy standpoint, this suggests that some encouragement should be given to additional supplies if consumers and producers are to be weighted equally in the policy process. The North American Free Trade Agreement, which came into effect on January 1, 1994, has led to increased Mexican supplies as was anticipated at the time of its implementation. Additional supplies can be encouraged through the promotion of technical change in the Florida industry.

Discussion and Implications

The evidence from this research indicated that the winter market for fresh tomatoes was non-competitive. This meant that some rents were available in the market. The available rents were shared between Florida and Mexico with Florida, on the basis of casual evidence, having the advantage after 1978. The availability of rents in the market would certainly have provided a motivation for the "Great Tomato War" as the competition between Florida and Mexico in the 1970s was labeled (Bredahl et al., 1987).

The analysis suggests a greater battle for the market in the period up to 1978. However, in the 1980s and early 1990s, a loose leader-follower relationship appeared to have developed with Florida as the leader due to productivity increases relative to Mexico. The empirical results supported the exercise of market power by both Florida and Mexico. On the basis of a chi-squared statistic, the hypothesis that the market power held by Florida was equal to that held by Mexico could not be rejected.

Consumers were generally less influential than producers from the standpoint of policy but had gained considerably by the end of the period. The enhanced consumer standing in the policy process might have been due to greater sensitivity to consumer issues but also would have resulted more specifically from increased productivity and the declining effectiveness of the tariff. The increase in consumer awareness and organization would in part explain why the coalition of consumers and distributors were able to obtain a revocation of the controversial dual-sizing marketing order provision in 1973 and, to some extent, the inability of the US government to sustain the anti-dumping petitions filed by the Florida fresh vegetable industry. With regard to the latter, wider trade and economic issues did play a part.

While the empirical results provide evidence of significant market power, it cannot indicate its sources beyond the broad distinction that some would have emanated from the supply side and some from the demand side. Overall, not much is known about the sources of market power (Bresnahan, 1989). It is possible to speculate, however, on potential sources. One source which comes readily to mind is the marketing order which provides for some degree of supply control. Chambers and Pick (1994) conclude that

marketing orders which impose minimum quality standards can act as a non-tariff barrier. If this were correct in the case of the fresh tomato market, this would certainly have implications for enhancing price above marginal cost. Brandow (1968) contended that marketing orders have strengthened the power of several associations in fruit and vegetable markets. Bredahl et al., (1987) also indicated that the marketing order would increase producer surplus in Florida definitely and possibly in Mexico. Another possible source of power may be the export restraint policy practiced by Mexico. As was seen, Mexico tended to reduce its supplies by more than was anticipated by Florida and the effect of this would have been to raise the price.

Another possible source of market power may be the presence of some degree of product differentiation. The major aspect of this differentiation may be the distinction of location and the implications for market information and the requirements of the market. More specifically, Florida's presence in the market may provide it with an advantage with respect to market information and distribution. Another likely source of market power is the technical change which took place in the industry in Florida. A critical determinant of the conjectural elasticity is market share. Technical change causes outward shifts in the supply relation at given prices and consequent increases in market share. This factor will therefore influence market power.

The empirical results suggest that the US government should take action to increase supply if producers and consumers are to be treated equally. In the context of the conceptual model applied, the optimal policy might have been some type of import subsidy or, perhaps, the stimulation of productivity growth in the Florida industry.

NAFTA will phase out tariff and non-tariff barriers over time and is therefore consistent with the policy direction suggested by the empirical results of the model if more equitable weighting were to be given to consumer's and producer's surplus. The encouragement of increased imports from Mexico (or from other sources) would be harmful to the interests of producers in Florida since this would mean lower prices but would advance the interests of consumers through the encouragement of alternative supplies.

Therefore, producers in Florida can be expected to attempt to protect themselves from the effects of the provisions of NAFTA which would reduce Florida's market power by reducing its market share. There has been ample indication of this in the negotiations leading up to the implementation of NAFTA and more recently, with the filing in March, 1995, of a petition for provisional relief by Florida growers against imports from Mexico and of an anti-dumping action for more definitive relief over a longer period. This conflict between producer's surplus and consumer's surplus can be mollified if US government policy fostered productivity growth in the Florida industry. Such a policy, a political economic resource transaction (PERT) as discussed by Foster and Rausser (1990), can increase welfare while simultaneously advancing the interests of producers and consumers. Productivity growth would bring about increased supplies and lower prices while reducing production costs in Florida. Strong research and development programs aimed at effecting productivity-enhancing technical change in the Florida industry would be critical.

Economic and trade liberalization in Mexico and NAFTA will likely lead to productivity increases in Mexican industry as a whole and in the fresh vegetable industry

in particular (Dornbusch, 1992). Increases in productivity, ceteris paribus, will lead to increased market power on the part of Mexico to the extent that marginal costs are reduced. If, however, productivity increases occur in both Mexico and Florida, greater rivalry may be witnessed on the market with possibly lower prices. This scenario is all the more likely if demand continues to be relatively stagnant.

Another factor which will have an impact on market power is increasing government regulation with respect to the Florida industry. The Montreal Protocol calls for a ban on the production and use of methyl bromide as a soil fumigant in vegetable production in the US by January 1, 2001. The removal of methyl bromide will increase marginal costs in Florida relative to Mexico and lower, ceteris paribus, the market power of this supplier. There are several other regulations being implemented which increase the costs of production in Florida. These include regulations with respect to the availability and quality of water, labor management, pesticide use, wetlands and endangered species. All cost increases will raise Florida's costs and lead to reductions in the quantity supplied and consequently to reductions in market power.

Beginning in December, 1994, the Mexican peso lost considerable value relative to the US dollar. This has led, in part, to increased quantities supplied by Mexico as the price received by Mexican growers rose. Against a background of stagnant demand, this devaluation has meant expenditure-switching away from US domestic sources (Florida in the winter season) to Mexican imports. Thus Mexican market share has expanded and, consequently, the market power wielded by Mexico would have increased, ceteris paribus.

CHAPTER 6

SUMMARY AND CONCLUSIONS

Summary

Many markets have come to be recognized as imperfectly competitive (Bresnahan, 1989). This is more readily appreciated in the case of manufacturing but is also true of many agricultural industries. Although this recognition existed for some time, empirical applications based on econometric approaches have been slow to emerge, with a fair body of work developing in the late 1970s and early 1980s. A primary objective of this literature is the identification of the nature of imperfect competition on the basis of hypothesis tests. Often empirical applications presume a general framework which nests alternative hypotheses of competition ranging from perfect competition to monopoly. Estimation of the ratio of the profit margin to price is central to the analysis. In others, specific assumptions about market conduct are imposed a priori.

The objectives of this study were to evaluate the structure of the US winter market for fresh tomatoes and to assess the influence of producers and consumers in the policy process. This is a market in which significant battles were waged for supremacy between producers in Florida and Mexico, the only important supplier of imports, and between producers in Florida and US consumers. A strategic trade policy framework was adopted and a duopoly model was developed to describe the market in which Florida and Mexico were the key players. Together these two supply areas account for over

90% of total supplies during the January-April period. The US and Mexican governments have been actively involved in the market, with the aims of securing strategic advantage for their respective industries and of enhancing national welfare. In the conceptual model, a two-stage process was postulated in which the US government determined policy premised on optimal strategies by the respective industries. The industries, on the other hand, took US government policy as given when deciding their respective strategies. The Mexican government was assumed to be inactive from a policy standpoint in the analysis even though it was recognized that it influenced imports.

The conceptual model presumed that the industries in Florida and Mexico maximized profits and that the US government maximized welfare mindful of the implications of policy on consumer's surplus and producer's surplus. On the basis of the model, measures of oligopoly power for both industries were developed. A comparison of the market power exercised by both industries was facilitated. This distinguishes this study from previous studies which were generally concerned with the establishment of the degree of oligopoly power prevailing in the market as a whole. Evaluation of the measures of oligopoly power facilitates an understanding of the extent to which market power derives from the supply as against the demand side. The model also suggests what the optimal policy of the government should be based on the disparity between the conjectural variations of the Florida industry and the realized responses of the Mexican industry following a change in Florida's supply. If consumers are given equal weight, the policy should encourage increased supplies.

In the empirical model, a linear demand function and linear supply relations were used. An interaction term involving total quantity and the price of another commodity included in the demand equation served to identify the measures of market power. Given parameter estimates from the structural model, the elasticity of demand at the shipping-point, conjectural variations, conjectural elasticities and measures of market power were estimated. The realized Mexican response to a change in Florida's supply was also computed.

Conclusions

The statistical evidence suggested an inelastic demand at the shipping-point which contributed importantly to the finding of significant oligopoly power in the market. Conjectural variations, conjectural elasticities and measures of oligopoly power bear out the presence of market power on the part of both industries. Casual evidence suggested that there was a greater battle for the market up to 1978 in which period the values for the conjectural elasticities were sometimes close and Mexico had larger values for three of the eight years. After 1978, however, an upward trend in Florida's market power was evident while that of Mexico declined. Statistically, however, no difference in market power between Florida and Mexico was supported.

Policy preference weights were estimated on the assumption that the US government maximized welfare given as the weighted sum of producer's surplus, consumer's surplus and tariff revenue. The weights on producer's surplus and consumer's surplus were expressed in terms of the importance of tariff revenue since the focus was on the relative influence of producers and consumers. It should be noted that

producer's and consumer's surplus were premised only on prices and quantities of fresh tomatoes and did not consider other factors such as food safety. Producers were found to have more influence in policy formation than consumers in general. However, consumers became more and more important over the period of analysis. Disruptions in supply, as would occur in the instance of a freeze, appeared to be harmful to consumers' interests.

The existence of significant market power indicated the availability of rents in the US winter market for fresh tomatoes. This is an important finding in a primary agricultural commodity market. Primary agricultural markets are generally presumed to be competitive. One can only speculate about the precise causes of market power. Factors which might have contributed to the existence of market power include the federal marketing order, the export restraint policy practiced by Mexico, product differentiation and technical change. One policy implication of the empirical results is that additional supplies should be encouraged if consumers and producers were to be treated equally. NAFTA will increase the supply of imports and additional supplies from Florida can be promoted through efforts to increase productivity.

There are several other developments and trends (e.g., the removal of methyl bromide from use and increasing regulation) which affect fresh tomato production by increasing costs and lowering Florida's market power. Producers in Florida can be expected to attempt to protect their interests and, to the extent that they continue to be important from the viewpoint of policy, the US government will have to find ways to accommodate their concerns. The US government may be unable or unwilling to

interfere with the provisions of NAFTA but may provide relief through other measures such as increased funding for research and development which may affect costs as well as quality. Relief in the form of production subsidies may also be justified until alternative production practices are developed to offset increased costs due to regulation.

Suggestions for Further Research

The empirical results of this study are plausible in that they give a good description of the market under consideration. They confirmed much of what had been reported in previous studies. In particular, they gave a motivation for Florida and Mexico contesting the market so keenly in the 1970s; why Florida might have increased its influence in the 1980s; and they perhaps provided an answer as to why Mexico still finds it worthwhile to participate in the market. The results also yielded insight into why US consumers and the distributors of Mexican imports asserted themselves in the policy process. They even implied what desirable policy ought to be if consumers and producers are to be weighted equally.

Nonetheless, there are several areas where improvements or extensions can be made to this study. These include an investigation into the factors which explain the market power; a better representation of the totality of policies pursued by the US government; a consideration of a policy-active Mexican government; the adoption of the assumption of integration of US and Mexican markets; the consideration of strategic variables other than quantity; a consideration of differentiated products; and the adoption of a dynamic framework.

As previously indicated, not much is known about the sources of market power (Bresnahan, 1989; Lopez and You, 1993). In this study, possible sources include the marketing order, Mexico's export restraint policy, intrinsic product differentiation, commercial arrangements and differences in market information and technical change. It will be useful if the contributions of these various elements can be established.

There is no definitive evidence on the restrictive effects of the marketing order on imports and on their ability to enhance price above marginal costs (Grennes et al., 1991; Anderson; 1982). The same comment is perhaps relevant to Mexico's export restraint policy where no empirical work on its effects are known.

The assumption of a homogeneous product has been widely used in theoretical and empirical work and was considered appropriate in this specific case. However, it may be useful to extend this model to take account of differentiated products and evaluate whether there are significant changes in the qualitative results. In comparison with the present analysis, this would involve the inclusion of two separate demand curves, allowing the demand elasticities to differ by source of supply. This assumption would remove some of the emphasis from costs as the factor determining the type of competition.

It is also highly desirable to establish the amount of market power due to technical change. In real world situations, technical change is clearly a considerably important explanatory factor. It is not clear, however, that a static framework can adequately accommodate this issue (Dosi, 1984). In the empirical model used in this study, yield may be considered a more appropriate variable to capture technical change. However,

this served only to reduce the effect on the Florida quantity supplied on the price. To the extent that yield reduces the effect of quantity on price,(i.e., the parameter estimate becomes smaller in value), it reduces the value of oligopoly power measure. This runs counter to the reality of technical progress as a factor determining market power.

Some market power may also come from the commercial arrangements used by Florida and Mexico and from the flow of the relevant market information. This consideration can be included under product differentiation since it has to do with the ability of the industry to obtain different prices for their products.

In the empirical analysis, only the import tariff was explicitly modeled. It was recognized, however, that the marketing order had implications for prices and quantities on the market and the results were interpreted with this in mind. It would, of course, add greatly if the marketing order can be directly modelled, especially given its importance as a potential source of market power.

The model can be extended to allow for a policy-active Mexican government and, therefore, for retaliation between the US and Mexico. In reality, despite the choice to ignore it in this study, the Mexican government actively supported its industry and adopted or modified policies in response to actions taken by the US government to buttress the Florida industry. It will therefore be a useful refinement if a policy-active Mexican government could be considered.

The assumption of segmentation of US and Mexican markets was considered a reasonable assumption for most of the study period due to the export orientation of the Mexican industry. However, the Mexican domestic market has been growing recently

and has been taking an increasing proportion of the Mexican supply. The availability of another major market allows Mexican growers to allocate supplies between markets so that the highest returns can be obtained. This can mean greater confidence on the part of Mexican growers and greater competition, possibly resulting in an expanded supply capability.

The only strategic variable assumed in this study is quantity. However, other strategic variables may be explored. For, instance, price may be used as the strategic variable in a product differentiation case. However, another relevant strategic variable, especially in the context of NAFTA, may be research and development which may affect costs and quality. Consideration of research and development as a strategic variable may, however, require a dynamic framework.

APPENDIX

A-1. Data Set Used in the Analysis--Fresh Tomato Quantities and Prices

Year	Quantities			Price ($/25 lb)
	Florida (25 lb.)	Mexico (25 lb.)	Total (25 lb)	
1970	7380800	22689600	30070400	3.84
1971	8180800	16444800	24625600	4.91
1972	11761600	19268800	31030400	4.09
1973	8819200	22936000	31755200	4.01
1974	11121600	17904000	29025600	5.78
1975	14609600	15609600	30219200	5.20
1976	13464000	17297600	30761600	5.42
1977	5819200	22419200	28238400	7.83
1978	9580000	25772000	35352000	5.87
1979	13435200	20508800	33944000	6.72
1980	16572800	19446400	36019200	5.00
1981	13715200	16270400	29985600	11.07
1982	18540800	16459200	35000000	6.73
1983	18987200	17886400	36873600	8.65
1984	16689600	20448000	37137600	8.08
1985	16987200	22291200	39278400	8.84
1986	20340800	22926400	43267200	6.29
1987	20523200	22246400	42769600	5.85
1988	27086400	18291200	45377600	6.58
1989	27040000	14777600	41817600	9.44
1990	17976000	19308800	37284800	13.29
1991	25723200	19979200	45702400	7.63
1992	30692800	6649600	37342400	13.74

Sources: Marketing Florida Vegetables, USDA/AMS, various issues.
Marketing Mexico Fruits and Vegetables, USDA/AMS, various issues.
Annual Reports, Florida Tomato Committee, various issues.

A-2. Data Set Used in the Analysis--US GNP, Population and US/Mexico Exchange Rate

Year	GNP (US$ Billions)	US Population (Millions)	GNP Per Capita (Thousands)	US/Mexico Exchange Rate ($)
1970	1016.8	205.05	4.96	12.5
1971	1104.5	207.66	5.32	12.5
1972	1215.2	209.90	5.79	12.5
1973	1361.8	211.91	6.43	12.5
1974	1473.7	213.85	6.89	12.5
1975	1598.1	215.97	7.40	12.5
1976	1748.1	218.04	8.02	15.4
1977	1994.6	220.24	9.06	22.6
1978	2254.6	222.59	10.13	22.8
1979	2520.8	225.06	11.20	22.8
1980	2742.1	227.76	12.04	23.0
1981	3063.8	229.94	13.32	24.5
1982	3179.8	232.17	13.70	56.4
1983	3434.5	234.30	14.66	120.1
1984	3801.5	236.37	16.08	167.8
1985	4053.6	238.49	17.00	256.9
1986	4277.8	240.68	17.77	611.8
1987	4544.5	242.84	18.71	1378.2
1988	4908.2	245.06	20.03	2273.1
1989	5248.2	247.34	21.22	2461.5
1990	5524.6	249.92	22.11	2812.6
1991	5737.1	252.18	22.75	3018.4
1992	6045.8	255.02	23.71	3094.9

Source: International Financial Statistics, International Monetary Fund, various issues.

A-3. Data Set Used in the Analysis–Wages, US Interest Rate, Import Tariff, Green Pepper Price and Freeze

Year	Mexican Wage ($/day)	Florida Wage ($/day)	Interest Rate Index (1977 = 100)	Import Tariff ($/25 lb)	Florida Green Pepper Price ($/25 lb)	Freeze
1970	1.99	11.68	39	0.46	5.58	0
1971	2.14	11.44	43	0.47	3.90	0
1972	2.32	12.40	47	0.47	4.09	0
1973	2.47	16.72	55	0.47	4.14	0
1974	3.10	18.64	65	0.46	4.90	0
1975	3.93	20.16	77	0.47	4.96	0
1976	4.45	21.84	88	0.45	5.45	0
1977	3.66	22.96	100	0.47	5.66	1
1978	3.88	25.52	117	0.46	5.17	0
1979	4.54	27.76	143	0.46	6.16	0
1980	5.45	29.52	174	0.46	7.13	0
1981	6.59	33.20	211	0.47	8.10	1
1982	5.47	31.76	242	0.45	7.00	1
1983	4.12	34.64	250	0.47	9.45	0
1984	3.92	36.88	248	0.46	7.75	1
1985	4.22	36.88	228	0.47	6.59	1
1986	2.69	36.72	211	0.46	6.83	0
1987	2.27	37.92	189	0.45	12.00	0
1988	2.53	39.04	182	0.44	6.28	0
1989	3.33	39.68	180	0.45	6.99	1
1990	3.30	43.52	177	0.44	7.51	1
1991	3.90	45.36	169	0.45	10.79	0
1992	4.04	46.96	167	0.43	8.44	0

Sources: VanSickle et al., 1994.
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BIOGRAPHICAL SKETCH

Kenrick H. Jordan was born on January 21, 1955, in Trinidad and Tobago to McDonald and Martina Jordan. He graduated from high school (St. Mary's College) in 1973, having completed the general certificate of education at ordinary and advanced levels.

After teaching at secondary level for two years, he attended the University of the West Indies from which he received the Bachelor of Arts (BA) in economics in 1978. In 1985 he received the Master of Arts (MA) in development economics from the University of East Anglia in the United Kingdom. He enrolled as a graduate student at the University of Florida in August 1989 and was awarded the Master of Science (MS) in food and resource economics in 1991. He continued studying towards the doctor of philosophy (PhD) in food and resource economics beginning January, 1992. He received the PhD in 1995 with specializations in international trade and agricultural marketing.

Kenrick worked as an economist with the Caribbean Community Secretariat from 1980 to 1989. He is married to Anne Marie; they have two children, Keon and Deniece.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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